

Title: Characterising Graduatness in Computing Education: A Narrative Approach

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Abstract:

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It is commonly defined as the attributes all graduates should develop by the time they graduate regardless of university attended or discipline studied (Glover, Law and Youngman 2002). This work takes a different perspective grounded in disciplinary and institutional contexts. It aims to explore how graduates make sense of their experiences studying computing within their wider learning trajectories.

The research presented here uses a narrative approach. Whilst narrative methodologies are not commonly used in computing education, people construct stories both to make sense of their experiences and to integrate the “past, present, and an anticipated future” (McAdams 1985, p.120). Stories are then a particularly appropriate way of examining the sense people make of their learning experiences. This work draws on narrative interviews with graduates from the School of Computing at the University of Kent and Olin College of Engineering in the United States.

It contributes a new perspective about the effect of a computing education beyond short-term outcome measures and proposes several analytic constructs that expose significant aspects in participants’ learning experiences. In this, it describes themes related to students’ acquisition of disciplinary knowledge and examines the evolution of their stories of learning computing over time.

Characterising Graduateness in Computing Education: A Narrative Approach

A thesis submitted to
the University of Kent
in the subject of Computer Science
for the degree of Doctor of Philosophy.

By Sebastian Dziallas

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“The past and the present live alongside each other in our working lives, overlapping and intertwining, until it is sometimes hard to know where one ends and the other starts.” (Rebanks 2015)

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Abstract

This thesis examines the concept of gradueness in computing education. Gradueness is related to efforts to articulate the outcomes of a university education. It is commonly defined as the attributes all graduates should develop by the time they graduate regardless of university attended or discipline studied (Glover, Law and Youngman 2002). This work takes a different perspective grounded in disciplinary and institutional contexts. It aims to explore how graduates make sense of their experiences studying computing within their wider learning trajectories.

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Introduction

The actor Tom Hanks recently reflected on his formative years in community college in an opinion article in the *New York Times* (Hanks 2015). Hanks attended Chabot College in Hayward, California, where students from diverse backgrounds come together. He writes:

For thousands of commuting students, Chabot was our Columbia, Annapolis, even our Sorbonne, offering courses in physics, stenography, auto mechanics, certified public accounting, foreign languages, journalism — name the art or science, the subject or trade, and it was probably in the catalog.

Having graduated from Chabot, Hanks attended Sacramento's State University before dropping out after a year to pursue an internship. Yet, the courses he took at Chabot had a lasting effect on his life.

Classes I took at Chabot have rippled through my professional pond. I produced the HBO mini-series "John Adams" with an outline format I learned from a pipe-smoking historian, James Coovelis, whose lectures were riveting. Mary Lou Fitzgerald's Studies in Shakespeare taught me how the five-act structures of "Richard III," "The Tempest" and "Othello" focused their themes.

Looking back at this time in college,¹ Mr. Hanks writes:

¹ The term college in this thesis refers to tertiary education providers in the US, while the term university is used to refer to similar institutions in the UK. Where others, particularly in interview transcripts, are quoted, these terms generally have the meaning commonly adopted in

Chabot College is still in Hayward, though Mr. Coovelis, Ms. Fitzgerald and Mr. Kennedy are no longer there. I drove past the campus a few years ago with one of my kids and summed up my two years there this way: “That place made me what I am today.”

The work in this thesis is interested in how students’ experiences – like the ones of Mr. Hanks at Chabot – and the sense they make of them lead them to become who they are today. The answer, of course, is different for each individual. One place it can be found is in stories, like the one Mr. Hanks tells. This work draws on such stories and employs qualitative, narrative methodology to explore students’ wider learning trajectories.

Student trajectories are, obviously, influenced and shaped by the educational institutions they attend: different institutions offer different experiences. The goal of this thesis is then to leverage students’ conception of their own education to characterize “graduateness”. Graduateness, as a concept, represents characteristics that are developed as a result of the university experience and are shared by all graduates (Steuer, Jansen and Hofman 2016). Different definitions of graduateness emphasise different aspects, such as skills and knowledge, personal development, or generic capabilities (of cognition or presentation for example). This thesis proposes a more nuanced examination of graduateness, of the meaning and contribution of an undergraduate education as a whole, in the diverse and changing discipline of computing. Broadly, the aims of this research are then to:

their context. This means that in studies 1 and 2, college refers to secondary education providers for students over the age of 16 in the UK, while in study 3 it refers to institutions of higher education in the US.

- investigate computing students’ conception of their undergraduate education, within their wider learning trajectories, and
- discover and characterise what sense individuals make of their own “graduateness”.

The following briefly discusses the motivation for this work before turning to existing research on the effect of a university education.

Motivation

First, computing is a notoriously fast-moving discipline, where large technical advancements can quickly alter relevant disciplinary knowledge. The ACM curriculum recommendations highlight the importance of lifelong learning: “Curricula must prepare students for lifelong learning and must include professional practice (e.g., communication skills, teamwork, ethics) as components of the undergraduate experience” (Joint Task Force on Computing Curricula 2013, p.21). Indeed, after they leave university, graduates are unlikely to use the specific applications and techniques they have learned, although the intellectual utility of algorithms, theories and principles will of course persist. As one of the study participants observes:

I think especially if you do start working in computer science, as I said, if you want to stay on the ball and continue doing exciting stuff, you need to be willing to learn new things pretty much all the time. ... I think unwillingness to learn makes life difficult for you. (Peter Grant)²

² The names of participants, members of staff, and the companies they worked at have been replaced with pseudonyms. These pseudonyms have been preserved throughout different

The work in this thesis aims to explore graduates' views of their undergraduate education in the context of the demands imposed by these fast-paced technological developments.

Second, industry demand for qualified computing graduates in the UK is high, with a majority of large companies experiencing “tech skill gaps” (ECORYS UK 2016). This even appeared in conversations with participants in this work, who are now themselves recruiting graduates.

We don't know where all the computer science graduates are going. ... I run a lot of graduate projects and so I struggle when we get graduates in who know bits and pieces in, let's say, C. They've done electrical engineering and they're moderate with writing something small in C or something like that, but then you give them a big software development project, this proper object-orientated code that's well maintainable and written using all the nice object-orientated notions of inheritance and things like this, they struggle to do it. (Jordan Parker)

Employers are seeking graduates with certain characteristics that suit their needs – and when they find them at particular universities, they are likely to return. As one employer noted: “If you find fish, you go fishing there next time” (Fincher 2017). This work is interested in what constitutes these differences between institutions and in how they are reflected in student gradueness.

chapters and transcripts. (So “Jane” is always “Jane” whether talking herself or being referred to by someone else.) Where details in interviews have been changed to preserve participants' identity, this is represented in square brackets.

Third, it is hard for academic departments to understand the cumulative effect of the undergraduate experience they provide. While institutions tend to survey their graduates in a number of ways to assess the effect of their education (e.g. *MIT Institutional Research: Surveys* n.d.), educators often only have access to immediate, short-cycle, feedback on separate modules through end-of-year outcomes and surveys. There is little opportunity to either reflect on, or gather data on, the totality of an undergraduate education. Consequently, it is hard for educators and departments to make informed decisions about large-scale changes to curriculum or environment and, when such decisions are made, they are based on partial, time-bound evidence. Indeed, a report commissioned by the Royal Society on computing education in UK schools observed: “Given the increasing impact of data and computing in our society, understanding the long-term impact of the subject on the curriculum and on pupils is essential” (The Royal Society 2017, p.96).

The Effect of a University Education

University reflects a profound time of individual development for students, not only in terms of disciplinary knowledge and skills, but also in terms of their personal growth (McGrath et al. 2015). As one participant in this work noted:

It was a time of freedom, and time, and discovery, and learning, academic learning as well, and socialising, and drinking, and all of those things. I had such a feeling of hope for the future, and expectation from the future, and the future could go anywhere. “I don’t know where I’m going, and I’m on the way up, and I’m starting life.” (Christopher Hartley)

The question of how students change at university has been a frequent topic of research (Pascarella and Terenzini 2005). Broadly, there are two different kinds of approaches to studying the effect of a university education: those that

examine student development *throughout* higher education and those that are more concerned with the *specific qualities* that students have attained by the time they graduate. In the former category are theories of student (and identity) development, including community of practice approaches, whereas the latter category is characterised by work on graduate outcomes.

Student & Identity Development

Theories of student development, particularly in the psychosocial realm, often build on the work of psychologist Erik Erikson. Erikson proposed a model of development in which we, as humans, have to resolve a psychosocial crisis at eight stages over the course of a lifetime (Erikson 1968). These stages are not linked to each other: A positive outcome in one stage (e.g. intimacy in young adulthood) does not guarantee similar outcomes in later stages.

Table 1: Erikson's Stages of Development

Age	Psychosocial Crisis
Infancy	Trust vs. Mistrust
Toddler	Autonomy vs. Shame and Doubt
Early Childhood	Initiative vs. Guilt
Elementary School Age	Industry vs. Inferiority
Adolescence	Identity vs. Role Confusion
Young Adulthood	Intimacy vs. Isolation
Adulthood	Generative vs. Stagnation
Old Age	Ego Integrity vs. Despair

As students spend their adolescence at university,³ the main psychosocial crisis of that period concerns identity development. McAdams and Guo write: “The college years are prime time, Erikson believed, for exploring different options

³ Of course, not all students attend university immediately after graduating from school. Indeed, some participants in this work returned to university as mature students.

with regard to ideals and work and eventually committing to particular ideological positions and work roles that promise to provide a life with some degree of significance, meaning, and purpose” (McAdams and Guo 2014, p.15).

Researchers have explored this development as part of larger frameworks. For example, in 1969, Chickering drew on existing data to propose a systematic, integrated framework to describe students’ experiences at university through seven vectors of student development (Chickering 1969). These vectors describe the overall student experience, with identity development as one component:

1. Developing competence⁴
2. Managing emotions
3. Moving through autonomy toward interdependence
4. Developing mature interpersonal relationships
5. Establishing identity
6. Developing purpose
7. Developing integrity

While Chickering’s vectors explore several different aspects of student development, a number of researchers have specifically focussed on students’ *identity* development. Ruthellen Josselson conducted a longitudinal study of women’s identity development from university all the way to midlife (Josselson 1987; Josselson 1996). Over the course of multiple decades, she engaged her study participants in extensive interviews and, as a result, gained deep, personal insights that allow her to characterize individual participants in her reporting. She employed methods of qualitative analysis and developed different categories

⁴ Chickering’s definition of competence is not exclusively based on the acquisition of disciplinary knowledge, but also includes social and higher-order cognitive skills.

of identity development (which she calls gatekeepers, pathmakers, searchers, and drifters) from the patterns she observed (Josselson 1996).

In another longitudinal study, Marcia Baxter Magolda relied on annual interviews to follow the lives of 39 participants beyond university. She developed the concept of *self-authorship* to describe students' ability to make meaning of their own lives, rather than to rely on external formulas (Baxter Magolda 2001). Both authors are primarily concerned with the identity development of their participants as individuals, and their works are not additionally grounded in disciplinary and institutional contexts, which play a significant role in influencing the student experience.

Community of Practice Approaches

Another way of examining student development at university, that does take the disciplinary context into account, is through the concept of “communities of practice” first established by Lave and Wenger (Lave and Wenger 1991).

Lave and Wenger's early work was conducted in apprenticeship situations where practice is paramount: In a tailor's shop one cannot distinguish material from meaning, and those skilled in the practice of the craft are visible by their work. So an apprentice tries out their skill on offcuts of cloth and on low-value work (or work for low-value customers). As they become better at the practice of tailoring, they work on more complex, higher-value pieces for more prestigious clients. In the tailor's shop, as in the studio and the atelier, everyone is working at the same thing, albeit at different levels (Lave 2011).

Influenced by apprenticeship, Lave and Wenger theorise that learning means joining a community of practice where people are brought together by common activities and by “what they have learned through their mutual engagement in

these activities” (Wenger 1998, p.2). This engagement takes place via the process of *legitimate peripheral participation*, which describes the process of becoming increasingly involved in a practice as one becomes more experienced (Lave and Wenger 1991).

Community of practice theories have been well explored in computing and engineering education research. These approaches can be grouped into three categories. First, there are efforts to develop a community of practice amongst practitioners. For instance, Fincher and Tenenberg describe their work to create a community of practice of computing education researchers through the *Bootstrapping* project (Fincher and Tenenberg 2006). Second, some researchers specifically focus on students’ identity development. Zander et al. examine students’ written biographies and develop several different identity categories, which they then arrange in a hierarchy (Zander et al. 2009). And Kinnunen et al. work to understand the “CS identity” of incoming students in several contexts using questionnaires (Kinnunen et al. 2018).

Third, researchers use communities of practice as a framework to analyse student discourse and curricular materials. In this category, Gilbuena et al. use discourse analysis to examine conversations between an instructor and several student teams. Specifically, they highlight students’ enculturation into disciplinary, industrial, and student communities (Gilbuena et al. 2015). In terms of curricular materials, Guzdial and Tew use the concept of legitimate peripheral participation to analyse media computation courses for non-majors (Guzdial and Tew 2006). Following Lave and Wenger, they consider that learning depends on a person’s role in a community of practice (Lave and Wenger 1991). For learning to occur, the material being taught has to be aligned with students’ perceived community of practice. This alignment rarely exists for non-majors, who often only take a single introductory computing course and do not find that course to

be aligned with their personal goals (Guzdial and Tew 2006). Guzdial and Tew examine existing courses and describe how the perception of alignment with a community of practice can be created.

Graduate Outcomes

There has recently been increased attention on the outcomes of university education in the UK (e.g. Birkin, Evans and Moreton 2016). McGrath et al. explicitly link the focus on outcomes of university education to the introduction of tuition fees following the *Dearing Report* (which were allowed to raise to £9,000 per year following the *Browne Review* in 2010) and the larger number of institutions and course offerings: “The change in funding arrangements and diversification of provision has contributed to greater pressure to justify to students, employers and governments increased investment in higher education” (McGrath et al. 2015, p.2).

Some of the posited post-graduation benefits, such as socio-economic outcomes, have been well-explored in the literature. The *Browne review* noted: “Higher education matters because it transforms the lives of individuals. On graduating, graduates are more likely to be employed, more likely to enjoy higher wages and better job satisfaction, and more likely to find it easier to move from one job to the next. Participating in higher education enables individuals from low income backgrounds and then their families to enter higher status jobs and increase their earnings” (Browne 2010, p.14). Other studies have similarly explored claims of university as a means for social mobility (e.g. Haveman and Smeeding 2006; Milburn 2012; Urahn et al. 2012).

Universities in the UK have begun explicitly highlighting the benefits associated with higher education, for instance as part of marketing materials for

prospective students. These materials commonly contain lists of aspirational attributes that students are expected to have by the time they graduate. They include generic aspects, such as professional and communication skills, critical and reflective thinking, global awareness, and creativity (e.g. *Graduate Attributes* | *University of Hertfordshire* n.d.; *Sheffield* n.d.; *The University of Edinburgh's Graduate Attributes* n.d.). For instance, the University of Portsmouth in the UK writes: “Portsmouth graduates will be knowledgeable, informed, intellectually curious, responsible, self-aware and self-motivated, independent learners set for success in their future careers” (University of Portsmouth 2016). More broadly, Bowden et al. emphasise that graduate attributes are “the qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution, and consequently shape the contribution they are able to make to their profession and as a citizen” (Bowden et al. 2000).

Researchers have also been working to develop metrics to characterise the contribution of higher education using the concepts of learning gain, value-added assessment, and gradueness (American Association of State Colleges and Universities 2006). The following examines these different concepts.

Learning Gain & Value-Added Assessment

Learning gain, as a concept, focusses on measuring the difference between a ‘before’ and ‘after’ point: It is “the ‘distance travelled’, or the difference between the skills, competencies, content knowledge and personal development demonstrated by students at two points in time” (McGrath et al. 2015, p.xi). In contrast, a value-added perspective is about how far a student outperforms their predicted performance, for instance in terms of test scores (McGrath et al. 2015). These perspectives have not been commonly used in the UK, although in 2015 the Higher Education Funding Council for England (HEFCE) funded 13

pilot projects across several universities to examine different ways of measuring learning gain (Higher Education Funding Council for England 2018).

Graduateness

Prior to the emergence of the concept of learning gain, discussion about the effect of university in the UK has most often been framed in terms of “graduateness”, which differs from learning gain and value-added assessment perspectives. (It is also different from the concept of employability, which describes attributes that increase graduates’ likelihood of being employed (Knight and Yorke 2003).) Historically, graduateness has been defined as characteristics that *all* graduates should develop. This has taken the form of comprehensive lists of attributes, including for example problem-solving and communication skills. However, the question of *which* attributes should be considered for graduateness has been the subject of much debate. In 1996, the UK Higher Education Quality Council (which has since become the *Quality Assurance Agency*) was concerned with establishing a set of minimum requirements for students at university in the UK regardless of institution or discipline and released a discussion paper to determine the “attributes of ‘graduateness’” (Higher Education Quality Council 1996). A particularly exasperated response in the *Times Higher Education* at the time noted: “This is sheer speciousness. ... there are good reasons for challenging the assumption of one immutable model of higher education to which all institutions should aspire” (Harris 1996).

Yet, existing research has largely focussed on just such aspirational lists of generic capabilities to be achieved by students regardless of discipline (Glover, Law and Youngman 2002). Students are held to have more or less graduateness when measured by generic quantitative instruments such as the *Reflective Thinking Questionnaire*, the *Motivated Strategies for Learning Questionnaire*, or the

Graduate Skills and Attributes Scale (Steur, Jansen and Hofman 2012; Coetzee 2014).

More recent efforts, such as those of Barrie and Jones, have highlighted different conceptions of gradueness (Barrie 2006; Jones 2009). For instance, Jones argues in her work that graduate attributes have been over-removed from their disciplinary context. She shows that they “are highly context-dependent, and are shaped by the disciplinary epistemology in which they are conceptualised and taught” (Jones 2009, p.85). She also writes that “treating [graduate] attributes ... as generic robs of them of their power” (Jones 2009, p.96). The approach in this thesis adopts a similar perspective that differs from traditional efforts to examine gradueness. It views gradueness as constructed through graduates’ individual narratives and is interested in students’ own conception of their education to capture their characterisations of what it means to undertake a computing degree and to engage in disciplinary activities.

This research stands alongside prior work to investigate the effect of university education. These efforts commonly draw on quantitative methods in the positivist research tradition to identify effects that are uniquely caused by university (Pascarella and Terenzini 2005). However, Pascarella and Terenzini also observe that “rendering tone, tint, texture, and nuance [of the university experience] may require the finer brushstrokes characteristic of qualitative approaches” (Pascarella and Terenzini 2005, p.637). And, methodologically, Elliot Mishler notes that working in the positivist tradition loses “... the pattern, form, and structure of trajectories of development” which are of particular interest in this work. (Mishler 2004b, p.51) This work is then not concerned with how *much* gradueness a graduate has “achieved” on a quantifiable scale by the time they leave university, as such a metric would not be able to describe the particularities of participants’ lived experiences.

What Lies Ahead

In the following, chapter 2 first reviews the literature on narratives (in computing education and elsewhere) and describes the narrative methods used in this work. Studies 1 and 2 (in chapters 3 and 4, respectively) then draw on the same data set – life story interviews with graduates from the School of Computing at the University of Kent. The two studies use different analytic approaches to explore the experiences of students who undertook a “placement year” and evolving conceptions of disciplinary knowledge, respectively. Study 3 (in chapter 5) shifts the focus to a longitudinal view of individuals’ stories drawing on repeated interviews with students at Olin College of Engineering, a small engineering college in the United States. It illuminates the wider narrative construction of people’s learning trajectories by returning to participants four years after the initial interview. Chapter 6 offers emergent observations about the role of different institutions in shaping gradueness from considering all three studies together. Chapter 7 highlights the contributions and limitations of this thesis.

Elements of this thesis are based on previously published material. Specifically, chapters 2, 3, and 5 are based on material published together with Sally Fincher at the *ACM International Computing Education Research* conference (Dzallias and Fincher 2016; Dzallias and Fincher 2018). Additionally, several aspects of this thesis draw on other publications, such as submissions to the Doctoral Consortium at the same conference (Dzallias 2015; Dzallias 2016). Chapter 5 also includes material from a pilot study (Dzallias and Fincher 2014) published at the *IEEE Frontiers in Education* conference.

Narrative Methodologies

Introduction

“Stories are for joining the past to the future. Stories are for those late hours in the night when you can't remember how you got from where you were to where you are. Stories are for eternity, when memory is erased, when there is nothing to remember except the story.” (O'Brien 2010)

Stories permeate lives: They are told at the end of the day when people get home from work; they are constructed over a lifetime; they are projected into the future; they are told, retold, and shared at family reunions. As Klapproth observes: “The human mind weaves the continuous flow of thoughts into the textures of stories – stories of what has been, of what will be, and of what could be. It is the narrative structuring of our world – and of ourselves within it – which makes our existence so particularly human” (Klapproth 2004, p.116).

Research approaches relying on stories have become increasingly popular under the umbrella of narrative methods. While the origin of modern narrative work can be found in life history work that emerged in the late 1920s (Goodson and Gill 2011), the contemporary study of narratives gathered momentum in the 1980s. Narrative approaches today represent a wide range of practices across different disciplines and are commonly used in psychology, sociology, anthropology, and oral history (Holstein and Gubrium 2011; Mishler 1995). As well as disciplinary diversity, narrative methodologies also use different methods: some approaches elicit narratives through interviews (e.g. McAdams et al. 2001), others examine individual speech acts (e.g. Bamberg 2004), and others again focus on folklore and tales (e.g. Klapproth 2004). This focus and emphasis has been described as a “narrative turn” in research (Riessman 2007).

This chapter reviews a variety of existing narrative approaches and then situates the approach of this work within them. As different approaches conceptualise the terms *narrative* and *story* differently, the next section establishes their use in this thesis, before turning to different forms of narrative analysis and identity.

Narrative and Story

There is no canonical definition of the term *narrative* (Plummer 2001), but the central feature of a narrative – a series of events being recounted – remains characteristic across domains. Labov, from a sociolinguistic perspective, defines a *minimal narrative* as “as a sequence of two clauses which are *temporally ordered*” (Labov 1972, p.360). Sarbin, a psychologist, highlights the role of narrative in organizing “episodes, actions, and accounts of actions” (Sarbin 1986, p.9). And Adler points to an emerging psychological consensus that narratives are “composed of structured reconstructions of events that describe characters and their shifting intentions over the course of time” (Adler 2012, p.370).

The term *story* is sometimes used synonymously with narrative, but there are important differences between the two: a story is a specific form of narrative. Its major events form a *plot* and it generally has a setting and characters, as well as a “narrative arc” which describes a beginning, middle, and ending (Plummer 2001). A story can also deploy literary devices, like climax or *dénouement*. The focus of a story lies with the actors, their actions, and the consequences. As Cheryl Mattingly observes, stories “are about someone trying to do something, and what happens to her and to others as a result” (Mattingly 1998, p.7).

However, certain forms of narrative, whilst chronologically arranged, do not or cannot draw on elements of story in their construction. For example, when writing a diary, the author cannot know what is going to happen next, cannot

give additional significance to an event than it has at the time it occurs, and so cannot place events in a dramatic arc (Fincher 2013). Such narratives are *non-storied*.

In this thesis, the term narrative serves as an umbrella for both storied and non-storied constructions. Throughout this work, non-storied narratives are distinguished from their storied counterparts (also referred to as “stories”), for which interpretive elements such as “the journey” or “turning points” are integral.

Narrative Analysis

The range of narrative approaches and their application in different disciplinary traditions has resulted in an equally wide range of analytic strategies.

Researchers have developed frameworks to categorise these different analytic approaches (e.g. Mishler 1995; Holstein and Gubrium 2011). For instance, Holstein and Gubrium identify three categories of analysis: the content and structures of narratives, the act of telling stories, and the societal and cultural influences on the stories being told (Holstein and Gubrium 2011).

The following outlines different narrative approaches diagrammed in Figure 1 and illustrates its quadrants with examples from the computing education research literature. The fact that an example is located in one quadrant does not mean that a researcher is confined there: they may have taken different approaches in other work.

Figure 1 is structured to position narrative artefacts *as data* and is constructed from the researcher’s point of view. The horizontal axis delineates characteristics of the narrative artefact itself, from storied to non-storied. On the non-storied end of the axis are narrative forms such as diaries, while an

example on the storied end is the life story (which is discussed in detail in the section on Narrative Identity below).

The vertical axis does not describe characteristics of narrative accounts, but of their analysis (and so also has epistemological implications). On the one end, analysis is concerned with preserving the individual, specific nature of the material even if researchers may set it in a wider thematic or theoretical context. At the other end, analysis is concerned with finding similar elements across many accounts (lives) which then become data for an argument, a thesis.

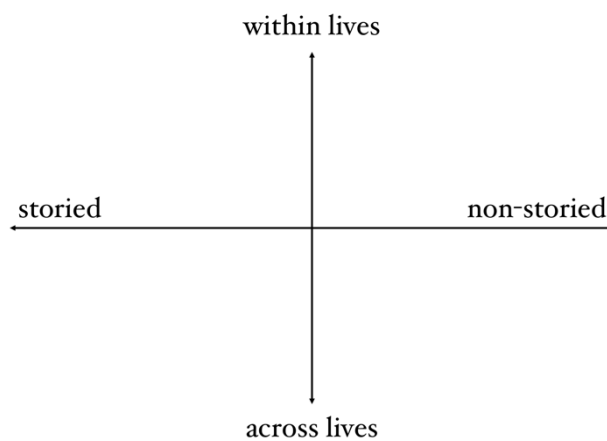


Figure 1: Different Narrative Approaches

In the top-left quadrant research is concerned with the stories people construct and the larger trajectories those stories contain. For instance, in his work on narratives of craft workers, Elliot Mishler adopts a case-centred approach to explore similarities and differences in individual narratives while maintaining their integrity (Mishler 2004b). He writes:

“The distinctive feature of this approach, and its fundamental requirement, is that individual trajectories of change are retained through all stages of analyses. Findings, therefore, do not refer to measures of

variables aggregated across groups of individuals but to similarities and differences among intra-individual or intra-case patterns of change....”
(Mishler 2004b, p.11)

McCartney and Sanders have employed a similar approach in their report of a longitudinal study of computing undergraduates. They justify their use of the approach by quoting Reed Stevens.

“Stevens et al. explain their choice of a similarly narrative approach by saying that they want to “get at the whole person’s experience ... to recover engineering students moving through their undergraduate educations” and capture “their individual pathways and experiences as engineers-in-the-making.” (Stevens et al. 2008)” (McCartney and Sanders 2015, p.152)

In contrast, the top-right quadrant focusses on authentic details without necessarily being concerned with larger trajectories. Research in this quadrant is exemplified by the 1940’s UK Mass Observation project which, for decades, sent questionnaires to its participants and regularly elicited responses to “day surveys” (in which respondents detailed their activities on the 12th day of each month). The Mass Observation reports provide insight into the individual circumstances of the respondents’ lives. Annebella Pollen quotes historian James Hinton, who observes:

“The more you try to use the writing of individual respondents as a basis for generalisation, the more you are forced to put to one side precisely what it is that MO [Mass Observation] can best reveal: individuals struggling to make sense of their lives. ... Individual subjectivity is always more complex than generalisations about the life of the group. Every

person does it differently; and the more one knows about any particular individual, the less they can be used to illustrate some more general experience or theme.” (Pollen 2014, p.4)

Much of computing education research is engaged with teachers and learners making sense of learning. Colleen Lewis in her microgenetic analysis of student debugging focuses on the individual narrative of one student’s engagement with debugging (Lewis 2012). Rather than following a particular individual, some researchers choose a narrative incident as their focus. Deitrick et al. describe the learning of a pair of middle school students through their non-storied discursive engagement with programming (Deitrick et al. 2015).

In the bottom-left quadrant are approaches that deal with multiple accounts, but accounts which concern themselves with storied reports, made meaningful by the contributor. For instance, Dan McAdams discovered an overarching theme across many life story interviews with adults who showed particular concern for the well-being of the next generation (as described by psychological measures). These adults often told stories containing *redemptive sequences* in which “bad” scenes – that describe negative circumstances – turn out well in the end (McAdams et al. 2001). As part of this work, McAdams and colleagues operationalised a definition of redemption sequences into a coding scheme which they used to develop more generalizable findings. Adler and colleagues provide a more general description of the process of coding narratives and training coders – which, as they observe, “will ultimately produce the quantitative representation of the narrative data” (Adler et al. 2017, p.524). Yet, work in this quadrant is not removed from the original narratives.

“Although researchers have developed approaches for streamlining the work, conducting narrative research fundamentally involves a deep

immersion in participants' stories, working to tease out their meaning in a valid and reliable way." (Adler et al. 2015, p.6)

Storied approaches are not common in computing education research, but Guzdial and Tew made an explicit examination of storied construction of pedagogic design in their early work on Media Computation classrooms (Guzdial and Tew 2006). And Mike Hewner's work investigating how students make course choices relies on the expression of personal and curricula trajectories (Hewner 2014).

In the bottom right-hand quadrant, researchers gather data from many sources, in a variety of ways, and work to find meaning across them that may not be evident from any single account. Beatrice Webb details this sort of analysis as central to investigation in social science: "The simplest (and usually the least fertile) way of expressing the results of an investigation is to follow the strictly chronological order in which the events occur" (Webb 1938, p.476). She describes the necessary work of breaking down narrative data "... to isolate and examine ... its various component parts, and to recombine them in new and experimental groupings" (Webb 1938, p.473). More recently, Teresa Amabile and others gathered and broke apart responses to 12,000 daily questionnaires to predict what events affect the experience and performance of members on project teams (Amabile and Kramer 2011b). And while Amabile and her colleagues acknowledge differences in how individual study participants experience events at work, their approach relies on collecting a broad sample of "frequent brief reports from many individuals across time" (Amabile and Kramer 2011a, p.119). An example of work in computing education research in this quadrant is an extensive study by Lister et al. examining novice programmers' reading and tracing skills. In interviews for that study, students were given a set of multiple choice questions and asked to "think out loud" as they worked to

answer the questions (Lister et al. 2004). This resulted in a collection of spoken and textual narratives, as Lister and colleagues also captured students' code traces (which they call "doodles"). These narrative fragments are temporally ordered accounts and describe students' actions; but they are, of course, non-storied.

There is an additional aspect to Figure 1, which draws on the epistemological element of the vertical axis. Those researchers who work *across lives* (in the bottom half of Figure 1) aim to make decontextualized and generalizable statements to establish an objective truth. Methodologically they work to seek, describe and compare quantifiable elements (such as affective, motivational, or integrative themes (Adler et al. 2015)) across many narratives – and in doing so, habitually devise and apply coding systems and aim for high inter-rater reliability ratings in testing their hypotheses. At the other end of the scale (in the top half) researchers focus on the idiosyncrasies of a life in context in analysis that “deals in human or human-like intention and action and the vicissitudes and consequences that mark their course” (Bruner 1986, p.13). Researchers here engage with the individual and particular and are not concerned with an objective “truth” of events, but rather with the sense people make of them. Methodologically, they often rely on the relationship of researcher and subject, the identification of emergent themes, and frequently explore individual cases in detail.

Alongside these differences of method and approach, the form that researchers choose to report their work also differs. Researchers in the top half of Figure 1 most often use a *narrative mode* of presentation such as case studies and comparisons. Researchers in the bottom half typically use numeric, or statistical presentations in a *logico-paradigmatic mode* (Bruner 1986; Polkinghorne 1995).

Stories & Meaning

People construct stories to make sense of their experiences and researchers, particularly in psychology, have increasingly turned to stories to explore the sense people make of important events, such as traumatic incidents (e.g. the 9/11 terrorist attacks) (Adler and Poulin 2009), divorce (Riessman 1990), and illness (Mattingly 1998). There is also empirical work that examines the benefits associated with the construction and re-construction of stories. For instance, in psychotherapy, narrative approaches have been used to relate narrative themes and mental health outcomes (Adler 2012). And in terms of illness, Mattingly examines how occupational therapists work with patients with chronic illnesses and severe disabilities (Mattingly 1998). She observes the tendency of patients who suffer from a “devastating, life-altering illness” to construct narratives. In her work, she describes how therapists and patients come to jointly construct “story-like structures” which are “integral to the healing power of this practice” through what she calls *therapeutic emplotting* (Mattingly 1998, p.2). This is an extreme form of re-writing of narratives, though stories are constantly revised by people (as we will see in study 3). As Habermas and Bluck write about work by Baumeister and Newman, “Embedding experience in a narrative is a fundamental way of making sense of it (Baumeister and Newman 1994)” (Habermas and Bluck 2000, p.749).

The aim of this thesis – to examine how graduates make sense of their computing education – is particularly well-suited to narrative inquiry. All three studies in this thesis are then concerned with *storied narratives*, that is with participants retrospectively relating events in a meaningful sequence. This situates them on the storied end of Figure 2, although they are located on different parts of the vertical axis as they have different aims and thus rely on different analytic methods.

Studies 1 and 3 aim to make some generalisable statements about graduates' narrative construction of gradueness, drawing on findings that emerge from thematic analysis (Riessman 2007). They examine experiences *across* multiple lives and are thus situated at the bottom of the quadrant, at point B. (Study 3 additionally contributes a longitudinal perspective.) In contrast, study 2 traces the individual trajectories of a small number of graduates using a case-centred approach (Mishler 2004b). It examines stories *within* lives, situating it at the top of the quadrant, at point A.

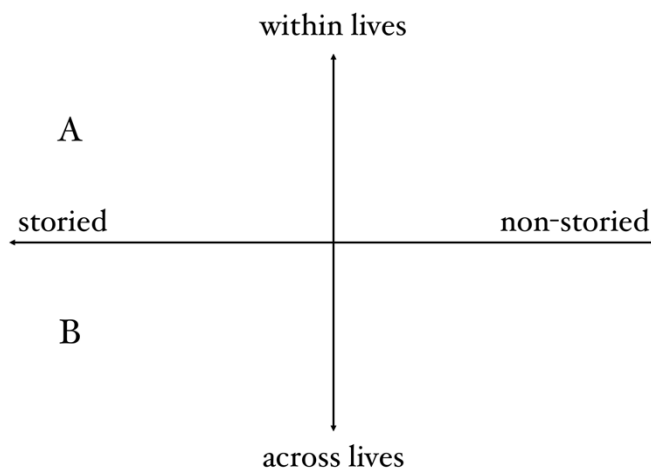


Figure 2: Narrative Approaches Used

Narrative Identity

A number of researchers have connected the notion of narratives to the concept of identity. Thorne distinguishes between autobiographical approaches which view “identity as a long-term personal project, more situated in the person than the situation, and oriented toward developing a coherent story across an individual’s past, present, and imagined future” and those which view “identity as a socially situated enterprise” (Thorne 2004, p.361). These latter perspectives are generally grounded in postmodern theory (Gergen 1991), and take an

interpersonal perspective of identity as shaped through discourse and social relations (e.g. Bamberg 2004; Mishler 2004b).

The work in this thesis is interested in narrative identity, particularly in terms of participants' learning experiences. It adopts an autobiographical approach in order to focus on participants' wider learning trajectories. As Thorne writes, a danger of the interpersonal perspective is that "the personal pasts of the speakers, the complexities of their current concerns, and their hopes and fears for the future seem illusory at best" (Thorne 2004, p.362). However, it is these aspects that are of particular interest in this work.

In terms of specific approaches to identity, Sfard and Prusak, for instance, "equate identities with stories about persons" and write that these stories that form one's identity must be "reifying, endorsable, and significant" (Sfard and Prusak 2005, p.16). In a commentary on their work, Mary Juzwik distinguishes the terms narrative and story and draws on previous research establishing a connection between *identity* and *story* through the concept of the *life story*. The life story reflects a person's sense of who they are and includes narratives from across contexts of their lifetime (Juzwik 2006). Juzwik incorporates this concept into Sfard and Prusak's framework. Rather than viewing a person's identity as a collection of undifferentiated stories, she argues that "reifying, endorsable, and significant" stories become part of a person's life story, which in turn forms one's identity (Juzwik 2006).

The approach in this thesis also focuses on the *life story* (situating it on the storied end of Figure 1). However, as with narrative, the term life story also encapsulates different approaches. According to Plummer, a life story is broadly an "account of one person's life in his or her own words" (Plummer 2001, p.18). This work follows McAdams, who argues that people construct stories to make

sense of their lives and integrate these stories into their life story, which in turn forms part of their personality.

McAdams describes differences in personality through a three-level framework consisting of dispositional traits, personal concerns, and narrative identity (McAdams 1995).⁵ To illustrate his point, he describes a fictional situation at a dinner party, where he and his wife meet someone named Lynn. Both of them had a number of interactions with her over the course of the evening, including conversations at the dinner table and on the patio. As they discuss their interactions with Lynn on their drive home, they develop a fuller picture of who she is, beyond initial superficial observations.

The first level in McAdams' framework represents broad dispositional traits. Research has consistently identified five dimensions to these traits: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (Costa Jr and McCrae 1992; Goldberg 1993). These traits remain relatively stable over a lifetime and allow for comparisons across contexts. It is easy enough to observe someone's traits within a matter of seconds; for instance, whether or not Lynn from the dinner party is extravert or introvert. But this only provides what McAdams calls a "psychology of the stranger" – a rather generic view of a person (McAdams 1994).

The second level consists of personal concerns, motivations, and goals which are contextualized within time and place and thus change over time. For example, they might learn at the dinner party about Lynn's political and religious beliefs.

⁵ More recently, McAdams has described the psychological self in terms of three layered standpoints: the social actor, the motivated agent, and the autobiographical author (McAdams 2013).

But this does not give any idea of how previous experiences have influenced her, and, indeed, how she has made sense of them.

Finally, the third level is the life story. For McAdams, we continually revise the life story as we “weave together the reconstructed past, the perceived present, and the anticipated future” (Adler and McAdams 2007, p.97). These stories are at the core of who we are and provide the self with unity and purpose (McAdams 2001). As Rosenwald and Ochberg observe: “A life story is more than a recital of events. It is an organization of experience. In relating the elements of experience to each other and to the present telling, the teller asserts their meanings” (Rosenwald and Ochberg 1992, p.8).

Psychologists claim that the emergence of a person’s life story is developmental: younger children between the ages of 5 and 10 – whilst capable of telling coherent stories of single events – do not construct life stories that integrate past, present, and future (Habermas and Bluck 2000). By the time they reach high school, however, this has changed. McAdams et al. interviewed college students and found that they were able to tell coherent life stories. In fact, when they interviewed the same students again, they discovered that their life stories exhibited thematic continuity over time (McAdams et al. 2006). Figure 3 shows the emergence of different elements of personality over time according to McAdams (McAdams 2013).

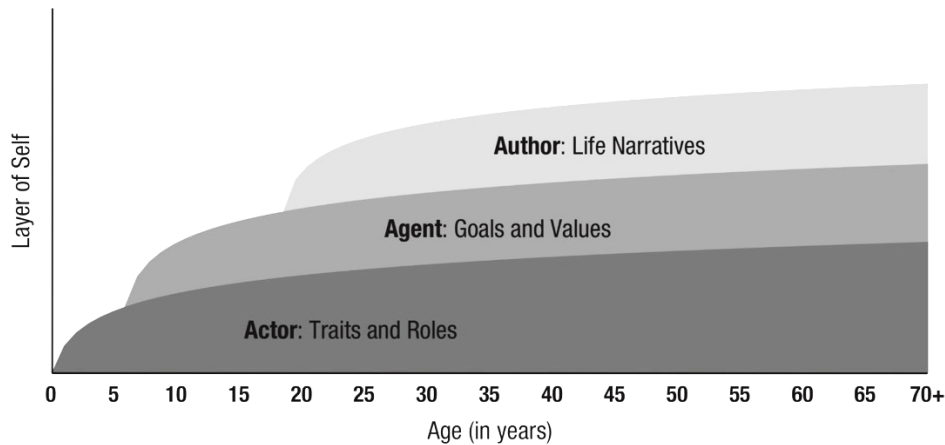


Figure 3: Layers of Personality, adopted from (McAdams 2013)

Life stories are not constructed in a vacuum. As Rosenwald and Ochberg write, “the explanations individuals offer of their lives are inevitably shaped by the prevailing norms of discourse within which they operate” (Rosenwald and Ochberg 1992, p.4). People tell stories differently in different cultures. For example, Conway et al. found that memory descriptions of Chinese study participants often centred around relationships with others, whereas the memories recounted by American participants tended to be self-centred (Conway et al. 2005). Another example are stories told among indigenous peoples. Barre Toelken recounts an encounter he witnessed between a Navajo Elder, Little Wagon, and a family that was passing by and had stopped for the night:

“Outside it had begun to snow lightly, and one of the travelers’ children asked where snow came from. Little Wagon, in answer, began a long and involved story about an ancestor who had found a piece of beautiful burning material, had guarded it carefully for several months until some spirits (*ye’i*) came to claim it, and had asked then that the spirits allow him to retain a piece of it. This they would not allow, but they would see what they could do for him. In the meantime he was to perform a

number of complicated and dedicated tasks to test his endurance. Finally, the spirits told him that in return for his fine behaviour they would throw all the ashes from their own fireplace down into Montezuma Canyon each year when they cleaned house. Sometimes they fail to keep their word, and sometimes they throw down too much; but in all they turn their attention toward us regularly, here in Montezuma Canyon. When this long story had been completed, there was a respectful silence for a moment; and then the young questioner put in: "It snows at Blanding, too. Why is that?" "I don't know," the old man replied immediately. "You'll have to make up your own story for that." (Toelken and Scott 1981, pp.72-73)

The story Little Wagon tells here is very different from the ones that we are used to. It is neither "once upon a time" nor a scientific explanation, yet seems to have elements of both. And in that it is perplexing, it does not intuitively "make sense" for us. Toelken similarly observes: "The literary point came to me later, as Little Wagon commented after the travelers' departure that it was too bad the boy did not understand stories" (Toelken and Scott 1981, p.73). He adds:

"I found by questioning him that he did not in fact consider it an etiological story, and did not in any way believe that that was the way snow originated; rather, if the story was "about" anything, it was about moral values, about the deportment of a young protagonist whose actions showed a properly reciprocal relationship between himself and nature. In short, by seeing the story in terms of any categories I had been taught to recognize, I had missed the point; and so had our young visitor...." (Toelken and Scott 1981, p.73)

This is an extreme example, but it illustrates the point that the context in which a story is told is important to our understanding of it. The stories presented in this thesis are drawn from two cultural contexts (although familiar ones), and this illustration serves as a reminder that we may not understand what “telling a story” means outside of its cultural framing.

Such cultural differences can also be seen in so-called *master narratives*, which narrators adopt and position themselves against; they construct personal narratives by integrating their daily experiences with these stories of culture (Hammack 2008). An example of this is the “redemptive self” in the United States, where life stories often involve tales of personal redemption (McAdams 2006). As McAdams writes:

“From rags-to-riches success stories to 12-step recovery programs ... burgeoning popular literature on self-help offers a cornucopia of redemption tales, as do television talk ... Politicians celebrate their own redemptive journeys: Ronald Reagan rose from a dysfunctional family; Bill Clinton (nicknamed “The Comeback Kid”) recovered from childhood poverty; George W. Bush turned his life around in his early 40s, after years of drifting and drinking; John Edwards started out “the son of a millworker,” but he rose from there.” (McAdams 2008a, p.23)

Although master narratives are highly pervasive, some narrators construct counter narratives against them (Bamberg and Andrews 2004). Two recent examples, which relate to the redemption narrative McAdams identified, are the Black Lives Matter and Occupy Wall Street movements which aim to draw attention to inequality and, in this, the inability to “achieve” the American Dream.

A life story is a selective reconstruction and does not automatically include all experiences an individual has had (McAdams 2011). Rather, it is constantly revised as an individual makes sense of their experiences. While McAdams has shown that there is an element of stability in the life story, he admits that it is not “*the* grand and totalizing narrative that makes all things make sense for all time in any given person’s life” (McAdams 2011, p.102). Indeed, some researchers go as far as to suggest that there are several life stories (Mattingly 2009). For instance, Rosenwald and Ochberg write: “Just as no one’s life is designed in advance, there is more than a single life story to be told. This is reasonable because the stories people tell are not only about their lives but also part of their lives” (Rosenwald and Ochberg 1992, p.8). There is then an active interplay between life as it is experienced and the stories someone tells about it.

If narratives, and life stories in particular, are constantly under revision, this raises questions about how they can be “reliable” units of analysis. Narrative researchers address this by moving beyond the positivist perspectives commonly associated with experimental studies (Mishler 1990; Mishler 1991). As Walther et al. write, a positivist view “assumes a transcendent, materialistic reality that can be known independent of context and time” (Walther, Sochacka and Kellam 2013, p.633). In contrast, narrative methods and the stories they elicit are of interest precisely because of what they reveal about participants’ interpretations of their experiences (Mishler 1990). As Rosenwald and Ochberg note: “the stories people tell about themselves are interesting not only for the events and characters they describe but also for something in the construction of the stories themselves” (Rosenwald and Ochberg 1992, p.1).

Conclusion

This chapter has examined different narrative approaches and situated the work in this thesis within them. Narrative identity provides “a theoretical framework,

a methodological technique, and an analytic approach” (Adler 2017, p.2). The work reported here is specifically concerned with participants’ “learning life” – that is, with the stories they tell about their learning experiences and how they change over time – in order to explore gradueness. A learning life includes prior experiences, from solving problems as a child at the kitchen table to time spent in school and university, as well as learning in the workplace in the present day and ideas about the future.

The work in this thesis reports on life story interviews with graduates from two institutions, the University of Kent and Olin College of Engineering. These interviews form the basis of this work to characterise gradueness in computing education by exploring how graduates make sense of their learning experiences at university and beyond. The following three chapters examine different aspects of the stories graduates tell about their learning lives.

Study 1: Narratives from the University of Kent

Introduction

This chapter draws on life story interviews with 35 participants from the School of Computing at the University of Kent to examine their construction of graduateness within their wider learning trajectories. In these interviews, transitions – and, more specifically, the School’s placement programme – emerged as an important aspect in their stories. In the following, this chapter outlines the methodology used, briefly describes the history and context of the department, and discusses three analytic constructs that highlight graduates’ conceptions of their experiences studying computing.

Methods & Participants

Ethical approval for this study was obtained from the Research Ethics Advisory Group of the Faculty of Sciences and participants were recruited via email through the University’s alumni office which was able to contact graduates who had completed an undergraduate degree at the School of Computing. In that email, graduates were invited to indicate their interest in reflecting on their learning experiences.

105 graduates responded and 97 were contacted with details about the study and to schedule an interview. (The remaining eight replied after most of the interviews had already been conducted.) Of the 97 graduates, some did not respond to further contact or were excluded from the study (e.g. those from different universities who had only spent a year studying away at the University of Kent but were still part of the alumni office’s data set); three also explicitly withdrew because of scheduling conflicts.

From the remaining respondents, 35 participants were ultimately selected and interviewed between July 2015 and March 2016. These 35 participants were chosen to ensure that a variety of graduation years was represented. There was not a participant from each year, but early and recent graduates are represented: the earliest participant graduated from Kent in 1985, the latest in 2015. Figure 4 shows the graduation years of the participants in this work and Appendix 2 includes their names and graduation years.

Most of the 35 participants studied Computer Science at the Canterbury campus, although a few studied Computer Systems Engineering (an early form of the computing degree offered at Kent in the 1980s which one participant described as “about 75% of the computer science programme and about 45% of the electronic engineering programme” (James Clarke)), Information Technology, or Business Information Technology instead. Some of them also went on to complete an MSc, MBA, or PhD at the University of Kent or another institution and discussed this as part of their reflections on their wider learning life.

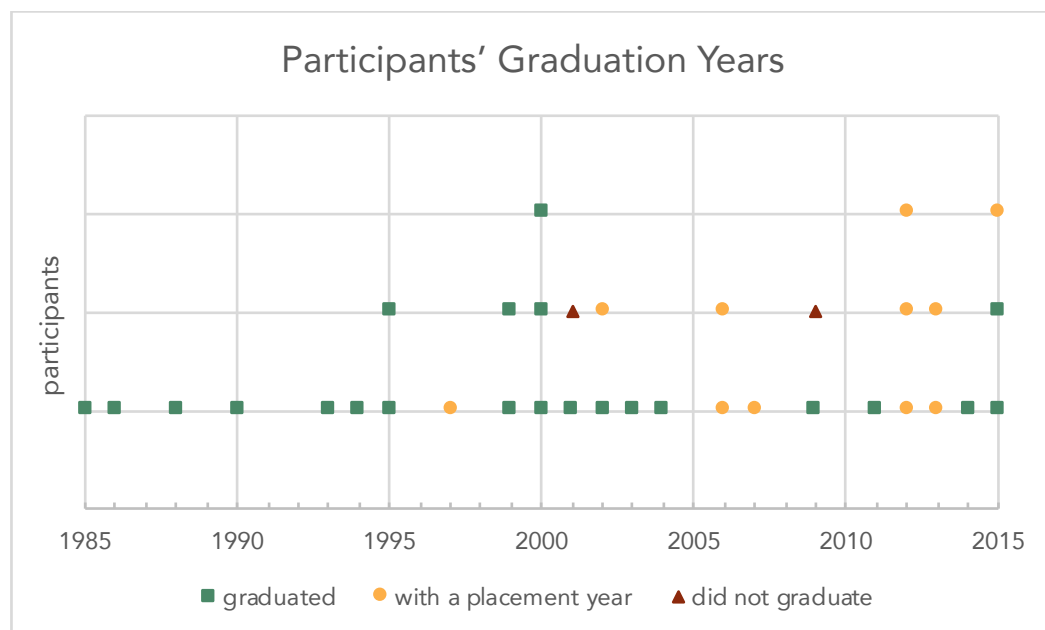


Figure 4: Participants' Graduation Years

Two participants did not graduate – they left higher education entirely in one case and for another university in the other. These two students are represented in Figure 4 in brown by what would have been their expected graduation year. Eleven participants completed a placement year working for an external company between their second and third year of study.⁶ Three (8.57%) of the participants were women, which is less than the current percentage of women studying computing at the undergraduate level in the School of Computing (approximately 15%). Two of the women were among the cohort of students who took part in a placement year.

Life stories were elicited from the 35 participants using the *life story interview*, which was originally developed by Dan McAdams (McAdams 2008b). The prompt was adapted to elicit participants' reflections on their learning experiences:

I'd like you to think about your learning career, your learning 'life', as if it were a book. Each part of your learning composes a chapter in the book. Certainly the book is unfinished at this point: still, it probably contains a few interesting and well-defined chapters. Please divide your learning 'life' into its major chapters and briefly describe each chapter. You may have as many or as few as you like, but I'd suggest at least 2 or 3 and at most 7 or 8. Think of this as a general table of contents for your book. Please give each chapter a name and describe its overall contents.

⁶ There were also two students who deferred their study at university by a year to work in industry, as well as others who came to Kent as mature students. However, as this was not part of the formal placement programme, their experiences are not included among the eleven participants.

At the end of the interview, participants were also asked:

Looking back over your learning career, can you discern a common theme or a central message?

As graduates were generally not now based in Canterbury, the interviews took place via Skype. In most cases, the interviews lasted 1-2 hours. They were recorded, professionally transcribed, and imported into NVivo for analysis. As participants were asked to describe the chapters of their learning life and to give each chapter a title as part of their interview, the chapter titles were initially collated for analysis.

Chapters, Self-Signification, and Transitions

Participants divided their learning lives into 3 to 14 chapters, although most identified five or six chapters, with an average of 6.03.⁷ Some graduates included little detail in their chapter titles, such as George Collins, who named his chapters: “maths A level”, “university”, and “life”. In contrast, David Bruce, who identified 14 chapters, described many different aspects of his learning life, as shown in Table 2.

⁷ One participant spoke more generally in terms of his chapters and is not included in this count: “I guess each chapter is marked by a clear end, but in my case, that would be the graduation. So like the beginning of the summer and going into the next, taking a break and then going into the next stage” (Alex Barlow).

Table 2: Chapter Titles for David Bruce

1. Early Experiments
2. Secondary School
3. The Computer Science Degree
4. Volunteering with the Student Union
5. Working at Jalia
6. Stuff I Picked Up from the Internet
7. Little Life Lessons
8. The Kindness of Strangers
9. Yaveo [name of the company he worked at]
10. Going Independent
11. Contractor Roles I've Known and Loved
12. Things I've Learned from Teaching
13. Mistakes I Have Made
14. The Future

The chapter titles a person uses provide insight into the meaning an episode has for them. In a comprehensive review of existing studies, Habermas and Bluck identified four types of coherence that provide unity within the psychological construct of the life story: temporal, causal, and thematic coherence, and the cultural concept of biography (Habermas and Bluck 2000). The latter accounts for differences in how members of different cultures recall autobiographical memory. Habermas and Bluck write:

“Temporal coherence and the cultural concept of biography are used to form a basic, skeletal life narrative consisting of an ordered sequence of culturally defined, major life events. Causal and thematic coherence express the unique interpretative stance of the individual.” (Habermas and Bluck 2000, p.750)

That is to say, regardless of the chronological sequencing of events, the way a person constructs connections in their narrative reflects their own perspective and the sense they make of the events being recounted.

The method of elicitation in this chapter foregrounds temporal and thematic coherence. Temporally, almost all of the participants divided their learning life chronologically into chapters according to the schools and university they attended and the jobs they held. One of them noted explicitly: “So I really saw my chapters just as kind of like stages of school” (Alex Barlow). Another participant, Scott Hyde, who moved countries while remaining at the same company, tied his chapters to geographic locations. For these graduates, each new chapter coincides with, and indeed describes, a transition to a new environment. Some graduates, like David Bruce in Table 2 above, followed a largely chronological order, but also included chapters with a particular thematic focus. And again others expressed their own interpretation, such as “A Whole New World” or “The Wilderness Years: Promise Unfilled”.

Summarizing and interpreting stories are two cognitive skills central to the development of thematic coherence (Habermas and Bluck 2000). In naming the chapters, participants express their own interpretation through a form of *self-signification*. David Snowden observes: “I often talk about self-signification as adding layers of meaning for good reason. The content of the narrative is only a part of the meaning that the contributor can supply, the way they interpret is also key” (Snowden 2011a). The act of naming then reflects the interpretive stance of the narrator, rather than that of the researcher (Snowden 2011b).

The power of this approach is evident in the account of one of the participants, who described his early foray into electronics in one chapter:

Then ... the next one [chapter] is going to be, possibly GCSE [secondary education certificate examinations in year 11] and possibly a little bit later where I actually diverged away from computing again. I went into electronics. Because I'd done computing [in school], I couldn't then carry on with it so I went into electronics and really enjoyed that for the next couple of years. ... We just happened to have a teacher [who] ... offered a GCSE. There were about 20 of us that did that. (Joe Stewart)

For a researcher, this would be easy to read as a positive and productive experience. But when asked to name the chapter, Joe responded:

That's ... the diverge away from computing so ... maybe "*a distraction*" or something, I don't know. I went on a slightly different course. (Joe Stewart)

This form of self-signification can then reveal meaning participants attribute to an experience beyond its mere description: unlike the term diverge, a "distraction" suggests a negative connotation that was not previously apparent to the reader.

Each chapter indicates the beginning of a new period in a person's life and, in this, transitions (or a lack thereof) become apparent through the chapters participants identified.

No, I would roll that in [to the same chapter] really because it all felt to me like the same kind of period of my life. (Tom Cooke)

Other researchers have previously examined the role of transitions in the context of higher education: They take place as students move from school to

university and from university into the workplace (Kyndt et al. 2017). For instance, O'Shea explores female first-generation students' identity formation in the context of their transition to university (O'Shea 2014). And Palmer, O'Kane, and Owens focus on students' sense of "not belonging" as they move from home to university (Palmer, O'Kane and Owens 2009). On the other end of the experience, Begel and Simon examine novice software developers experiences at Microsoft (Begel and Simon 2008). Most of this prior work does not draw on narrative methods, though there are a few exceptions (Holmegaard, Madsen and Ulriksen 2016; Ulriksen, Holmegaard and Madsen 2017).

One transition that students experience and that emerged particularly strongly in these interviews is when they take part in a "Year in Industry" (as the placement programme at the University of Kent is called), where they work for a company for a certain period of time as part of their degree. Almost all of the eleven graduates who had completed a placement year separated it into a new chapter.⁸ (Table 3 shows the names of these chapters.) In many cases, they were simply entitled "the placement year" or "working at Jalia". These titles reflect the next step in the temporal sequence of stages during university. But for some graduates, they also indicate the type of experience they had: the kind of company they worked at (for instance, a start-up or a small business), the geographic location, or the fact that they returned to the same company post-graduation (in the case of "Jalia Part One or USA").

⁸ Of the two participants who did not do so, one had deliberately not sought new work, but continued previous freelance work during his placement year. The other was the graduate mentioned above, Alex Barlow, who spoke more generally about his chapters.

Table 3: Year in Industry Chapter Titles

Applying Computing to Industry
Jalia Part One or USA
Placement / First Job (Workplaces)
The Placement Year
The Placement Year of the Startup
Welcome to the Real World
Working at Jalia
Working for a Small Business
Year in Industry

Of course, the terms *placement year* and *Year in Industry* serve as a catch-all for many different kinds of experiences: the people interviewed for this study worked at large consulting firms, smaller IT businesses,⁹ start-ups, and open source companies – and some of them spent time working in foreign countries. Each of these experiences is different in its own way, but there are also similarities.

Having identified transitions generally and the placement programme more specifically in participants' narratives, the remainder of this chapter focusses on the eleven graduates who completed a placement year. However, before doing so, we need to understand the context in which their experiences took place. The following then first turns to the School of Computing at the University of Kent.

⁹ For example, one participant who returned for his Year in Industry to a company he previously worked at noted that when he arrived for his placement year: "I knew everybody, I knew the receptionist. I knew the code for the door and all that sort of stuff. I knew how to get in through the fire door, all that sort of stuff" (Joe Stewart).

Interlude: Computing at the University of Kent

The University of Kent, where this study was conducted, is a medium-size public research-focussed, PhD-granting university in the UK that was founded in 1965 (UK Government Committee on Higher Education 1963). Today, the University of Kent has 15,455 full-time undergraduate students across various disciplines (University of Kent 2017). The School of Computing graduates between 150 and 190 students each year. The University's two main campuses are in the UK, located in Canterbury (the original site of the University) and in Medway, which opened in 2005. Computing degrees are offered at both sites. There are also several international locations, at Brussels, Paris, Athens, and Rome, although computing is not offered at those sites.

The University was established in the 1960s as part of a group of seven new institutions in response to growing student demand and recommendations of the Robbins report (1963). However, in addition to building capacity in higher education, the government advisory committee responsible for distributing funds to universities sought experimentation both in terms of the curriculum and the organisational structure of the university (Martin 1990). Two major distinctive aspects of the new university were its colleges and the lack of traditional departments and faculties.

The collegiate system at the University was modelled in part after the Oxbridge system. Students – whether or not they lived on campus – and academic staff were assigned a college upon entering the University, in part to integrate student residences and academic spaces and to encourage interdisciplinary interactions (Martin 1990). However, in contrast to Cambridge and Oxford, the colleges at the University of Kent were not individually equipped with substantial endowments and were not responsible for the admission and teaching of their students.

The original plan for the University lacked departments – with no sub-divisions within the three faculties (Humanities, Natural Sciences, and the Social Sciences) – as they were thought to be responsible for the growing specialisation in undergraduate degrees (Martin 1990). The faculties retained this lack of an additional administrative layer for several decades and, during this time, interfaced directly with individual academics. Academics were physically co-located based on their faculty *and* college membership. In practice, however, the experimental sciences often had separate laboratories where academic staff spent most of their time; this laboratory culture effectively overrode college membership (Martin 1990). This matches the observations of Burton Clark, who writes about higher education in general: “In short, the discipline rather than the institution tends to become the dominant force in the working lives of academics” (Clark 1986, p.30).

Computing at Kent was part of one such laboratory, the “Computing Laboratory”, which was initially established in 1968. At the time, it did not fit into the existing faculty structure, as computing had emerged in service of other disciplines which made use of computing facilities. Early on, computing students took a shared first year experience with other students in the Natural Sciences, as one student who graduated in 1985 recalls:

And Computer Science was fairly new in those days, and it got lumped in with the Natural Sciences. Now, everybody that was doing Natural Sciences did a largely common first year, so I started the first year the same as people who were doing Physics. And we only had about one or two additional lectures, for things like programming. (Anthony Gibbs)

As the role of computing as a discipline in its own right expanded and the number of students and staff increased, a new Faculty of Information Technology that incorporated computing, electronics, and mathematics was established in 1987. Additionally, a new building extension specifically for the Computing Laboratory was formally opened by Her Majesty the Queen.

Ultimately, as it grew in size, the University decided that the existing organisational structure consisting solely of colleges and faculties was not working and that it needed an additional layer below faculties. In the Sciences, where the laboratory culture had already been prevalent, this effectively led to a name change as the Computing Laboratory became the School of Computing (which, today, is part of the Faculty of Sciences). However, in the Humanities and Social Sciences, new academic schools had to be created, and some of these schools (e.g. the School of European Culture and Languages) now have additional departmental substructures. These new schools do not interact directly with senior management, but do so through the faculty level. With the shift from faculties towards schools, academics in their respective schools became physically co-located, rather than having their individual offices in colleges across campus. The college system that remains is largely student-facing at this point.

The School of Computing at Kent has particular strengths in a number of areas. Students have the option to choose a theme for their degree, from Artificial Intelligence, Consultancy, Networks, or, at Medway, for Health. Staff have published books on objected-oriented and functional programming (Barnes and Kölling 2016; Thompson 2011) and the Computing Education Research Group hosted the development teams for the BlueJ and Greenfoot programming environments, which are specifically designed for educational purposes, from 2005 until 2017. The School uses Java (and BlueJ) extensively throughout its

undergraduate curriculum; it is the first programming language students learn when they take computing at Kent. It offers several modules on functional programming and, in 2014, opened a makerspace with 3D printers and laser-cutters on campus. The School also runs the Kent IT Consultancy where students work as consultants and offer professional services to external clients.

As part of its provision, the School of Computing offers students the opportunity to take part in a placement year as a way of incorporating professional practice into their degrees. These kinds of programmes have long been identified as beneficial for graduate outcomes. The *Dearing Report* in the UK recommended “that all institutions should, over the medium term, identify opportunities to increase the extent to which programmes help students to become familiar with work, and help them to reflect on such experiences” (Dearing 1997, p.136). And, more recently, in the context of computing education, the *Shadbolt Review* in the UK identified placement programmes as an important contributor to improving computing students’ employability and similarly recommended expanding opportunities for students to gain such work experience (Shadbolt 2016).

Such programmes are not uncommon in practice-facing disciplines in higher education, although different disciplines vary in their approaches. For instance, medicine (and associated subjects with clinical components, such as Nursing and Dental Studies) will incorporate “clinical rotations”, where students go out into hospitals and work within a variety of specialities. Law departments often establish in-house “law clinics” where students work *pro bono* on cases alongside practicing lawyers. Computing’s approach has tended to be to interleave industry experience into the curriculum through “fully immersive” experiences (Fincher et al. 2004) where the student leaves the educational environment entirely and works within a professional environment for a period of time.

Cooperative placements (a semester in university, a semester in work), internships (a limited-time placement, often during the summer vacation), or “sandwich” years (the third of four years spent working in industry) are all common models. During these times, students work for and are employed by an external company. Whilst different institutions structure their placement programmes differently, a common element across these implementations is that they expose students to the workplace but require them to return to university to complete their degree. In the UK, placement programmes commonly follow the sandwich model. A typical computing degree at the University of Kent then takes three years to complete; and four years with a placement year.

The placement year programme at the School of Computing at the University of Kent was initially established in the mid-1980s and supported by a part-time employee from the Mathematics department. By the early 1990s, in response to student demand, the Year in Industry was reflected in graduates’ degree titles. At the time, only roughly 10% of students took part in a placement year.

In 1997, Tony West, who had graduated from Kent in 1974 and was working for Sun Microsystems at the time, contacted the University. As one participant in this study who took part in a placement year observed:

He [Tony West] wanted to improve Sun’s hiring of talent massively, because it was really flawed.¹⁰

¹⁰ The names of the interview participants in this section have been omitted, as the fact that they completed a placement year at Sun Microsystems (when taken together with their graduation year) might otherwise make them identifiable. Additionally, the names of companies

At this point, Java was well established in the School, as staff had become involved in using it in their teaching. The BlueJ programming environment was first released in 1999 and David Barnes published the first edition of his book *Object-Oriented Programming with Java* in 2000 (Barnes 2000). Kent also became the first university in Europe to be certified as an Authorised Academic Java Campus by Sun (Times Higher Education 1998). Three participants in this work explicitly noted this as a factor for choosing to study computing at Kent.

In 1999, a new Head of School, Professor Keith Mander, arrived from the University of York, where he had overseen a placement programme coordinated by dedicated staff. He adopted a similar structure for the Year in Industry programme at Kent and hired dedicated staff. One of these positions was initially paid for by Sun Microsystems to maintain the relationship with the company. This led to an increased number of students taking a placement year.

The School's relationship with Tony West and Sun Microsystems was important in increasing students' awareness of the Year in Industry.

He [Tony West] thought that the UK model of sandwich years was much better than the US model of internships, which were typically three to four months which is not long enough. And he wanted the assignments to be real jobs, or at least somewhat more real than internships, who typically would be given menial work and perhaps some exposure to specialists if there was time.

and members of staff in this section are not pseudonyms, as they reflect historical developments in the School.

Sun initially offered six students placements in 2000. This was a significant opportunity for students to spend a year working in the US for an internationally recognised company. As one participant who took part in a Year in Industry recalled:

[I was in] ... this video-conferencing room, which Sun paid for, in the electrical engineering building. It was surreal. There were six dedicated ISDN lines, or maybe eight, dedicated Polycom video conferencing crap. ... Of course, we were all in suits for this interview, and then across me is this Californian guy in a t-shirt, literally just like this in the meeting room. He would later be my boss, and he was, like, "You looked like newscasters."

At the height of the collaboration with Sun, in 2002, over 30 students were sent to Sun alone. (This included students from the Departments of Electronics, Economics, Mathematics, and the Business School (University of Kent 2002).) However, this was also the time of the dot-com crash.

It was very interesting, being at Sun when the dot-com crash happened, as a student. Buildings being built while you were there, and then they'd just stop and leave this skeleton on the grounds of this leafy campus. It was a very strange thing to see so young, and to see the problems of a company just exploding in size and in revenue and profit. And all the problems that that would bring, which ultimately led to it just dying as a company and being downsized many times, and eventually sold.

Still, as a result of the changes implemented in the late 1990s, the placement program within the school remains unusually strongly structured (Fincher and Finlay 2016). The school's dedicated placement office works with students on an

individual basis and helps with the preparation of CVs, applications, and with interview practice, gives talks and presentations throughout the curriculum, and visits students during their time on placement. Upon returning from their placement year, students deliver a poster presentation about their work experience to faculty and students in the School. Today, roughly 70% of all students pursuing an undergraduate degree in computing at the University complete a Year in Industry (Fincher and Finlay 2016). Figure 5 shows the evolution of three of the different degrees offered in the School of Computing.¹¹

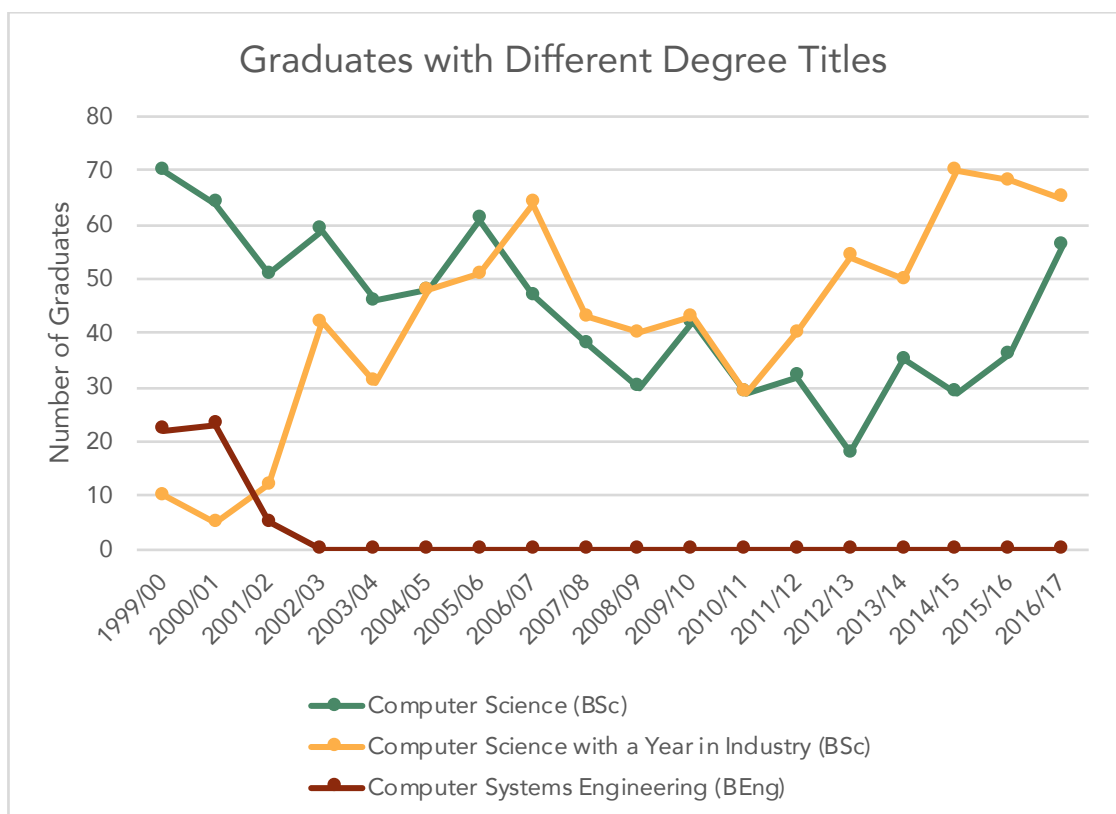


Figure 5: Graduates with Different Degree Titles

¹¹ Both the numbers for Computer Science with a Year in Industry in the year 2000/01 and Computer Systems Engineering in the year 2001/02 are only listed in the data set as less than five for data protection reasons. In order to visualize them, they are represented in this figure with the value five.

Figure 5 does not show the entire cohort of students for each year, as the School offered various additional degrees over the years, such as Business Information Technology, Computing and Business Administration, Information Technology, and so on (each of which additionally offered a Year in Industry option). The full table in Appendix 1 contains all of these degrees. This figure shows the decline in students taking the old Bachelor of Engineering degree, as the University transitioned to Bachelor of Science awards. It also shows that in the academic year 2006/07 the number of students who graduated after completing a Year in Industry exceeded that of students studying the “normal” Computer Science degree for the first time.

Before the placement year became a common part of the university experience, the students who went on a Year in Industry were left without their classmates when they returned to the University. As one student, who graduated in 1997, observed:

... most of my year had graduated, of course, by that stage. There were a few other people that I knew from my first two years who had gone off to placement and then come back. ... University felt a little bit more muted. ... So the people that I learnt with I didn't know anymore, except for the people who, as I say, had been on placement years as well. (Christopher Hartley)

In contrast, now, the high number of students completing a Year in Industry and the dedicated support mean that there is an expectation from the beginning for students to consider a placement year. Indeed, it can be surprising for those students who do not take part in it:

The jarring thing for the third year was that all the other people left to go and do their Year in Industry. (Benjamin Holland)

The Year in Industry

Effects & Perspectives

The *effect* of the Year in Industry experience overwhelmingly emerged in the interviews with participants, rather than in the individual chapter titles.

I think to be honest, that the placement year is pretty fundamental for where I am now in my life.... (Nathan Baker)

For some students, it provided insight into the kinds of work they wanted to do after they graduated.

Well, it showed me what I *didn't* want to do after I graduated. I was a tester for a small Java company, and although I found it interesting finding the bugs, it wasn't really something that I wanted to go into. (Alice Hayes)

People always say, don't they, "A Year in Industry, that made me decide I definitely wanted to [do x]." ... For me it was, "Yes, I *don't* want to go into industry, certainly not yet." (Joe Stewart)

It made me realise that start-ups are crazy and that it's a problem when you have no money. You have to go and chase money and what you do doesn't really matter. (Joel Bailey)

There was also a sense that most students returning from their Year in Industry (though not all, as discussed below) approached the final year at university in a different manner.

... and if I hadn't have done that [the Year in Industry] I dare say I would probably gone down a very different path. Just in terms of how seriously I took that final year and how hard I worked.... (Nathan Baker)

This transformation of attitude was apparent even to students who did not complete a Year in Industry themselves.

Quite a few classmates did do that [a Year in Industry]. In hindsight, now, I wish I had done it. I wish I had done it. The people that you saw, you met them in what would have been their fourth year, my third year, they work *differently*. (Emily Briggs)

In their study of recent college graduates in their first jobs in software development, Begel and Simon found that “many of the social and communication problems ... were rooted in the anxieties of working on a large team with a large, legacy codebase” (Begel and Simon 2008, p.13). Participants spoke vividly of their interactions with these large codebases.

... having to get to grips with the monstrosities.... Because some of this stuff was just insane. Design decisions that no one could agree with. It was just out of this world. (Jake Mason)

... then you go to something like this where there's this mess of other people's code, and it *kind of* works, and there are bugs, and you've got to

make it do this thing. Yes, 'overwhelming', I guess, was a word that I'd use. (John Warren)

At the same time, the work they were doing was often under tight deadline. Students were keenly aware of the differences between academic and workplace deadlines and the consequences of missing deadlines in this new context.

Your time management is so much better. Because if you don't deliver something for your boss on time, then he's going to be fucking pissed. (John Warren)

Part of the experience that participants commented on was their adaptation to the workplace and the development of time management skills which they then employed upon returning to university.

The first few times it happened – "Oh shit I've got two hours to fix this." And then towards the end you approach it very differently. You don't go into this blind panic of, "Aaargh. Deadlines. Deadlines." No, you sit there, you break it down, you manage your time and you get the job done. (Nathan Baker)

And so by third year, coming back after a year of working, it just completely changed my mentality. I was like, yes, this just needs to get done. I just need to set out a plan. Work out a weekly schedule, make sure I do the coursework early, and I worked out how much I needed to get in each piece of work to get the grade. (Alex Barlow)

Students also returned to university with newly developed skills and experience of working with others on teams.

So, after your sandwich year, you give a presentation. I gave a good presentation, because [Jalia] had trained me in presentation skills.

(Nicholas Bradley)

One graduate, David Bruce, described his experience of working on a team and how he realised the importance of team roles and good leadership.

So that was something that I appreciated. The value of a good project manager, as a result of that Year in Industry and what they can do.

(David Bruce)

He also reflected on the importance of communication skills when working on teams.

[Before] it was like, “That doesn’t matter. I’m a shit-hot programmer. I don’t need to care about what people feel.” It turns out if you do, and [if] you communicate nicely and respectfully with people, ...you get on a lot better in the world. It’s a lot easier. Everything goes a lot more smoothly.

(David Bruce)

In their work, Begel and Simon observe that “many of the problems they [new college graduates] have typically have a root cause in poor communication skills and social naïveté” (Begel and Simon 2008, p.13). The experience David Bruce describes indicates that the Year in Industry helped him realise the importance of these skills before entering the workforce upon graduating from university.

For many, though not all students, the Year in Industry was then a significant change from their time at university, as they spent a year in a non-academic

environment. This was reflected in the stories they told about their experiences. Three analytical constructs that emerged in the analysis of these interviews illuminate the significance of the Year in Industry. The first is the Year in Industry as a *turning point*, which marked a significant change in the narrator's life direction. The second is the notion of *boundary objects* bridging the academic and work environments. The third is participants' *autobiographic authority* as they return from their Year in Industry to university. They are used here to discuss the Year in Industry and gradueness more broadly.

Transitions & Turning Points

A Year in Industry is a transition for everyone who undertakes it. But for some graduates, it forms a more significant part, a turning point, in their life story. In their work, Enz and Talarico describe the difference between *transitions* and *turning points* (Enz and Talarico 2016). The former involve changes in external circumstances; in the words of Brown et al., they “alter the fabric of daily life” (Brown et al. 2012, p.167). For example, relocating to a different city or even country would be considered a transition. In contrast, turning points describe a change in the trajectory of a person's life – they are the “turns in the road” (McAdams, Josselson and Lieblich 2001). So while, for example, going to university and taking a Year in Industry marks a transition for everyone, it only becomes a turning point for some.

Turning points depend on a person's perception of change and the meaning they attribute to an event after it occurred. Thus, turning points only emerge in retrospective reflection. Elliot Mishler calls this the “double arrow of time” which, he writes, “is an inherent and intractable feature of how we remember and continually restory our pasts, shifting the relative significance of different events for whom we have become...” (Mishler 2006, p.36). This means turning points are individually constructed and personally meaningful. They may not be

reliably identifiable from the outside: identifying a turning point requires the narrator to explicitly establish causal connections between an event and a change in the direction of their life. (As a corollary, if the narrator does not view an event as contributing to a turning point in their life, we may never learn of its effect.)

This became apparent in the account of one graduate and his early exposure to computing. As Elliot Wheeler expresses it:

We got one of those [a ZX81, an early home computer] and I taught myself how to programme it in this Sinclair BASIC language and I got the magazines. That was my early enthusiasm for computing, and probably the thing that, at the time, was not a significant influence on me, but, looking back, has now probably been the most significant influence on where I am today, surprisingly. I can't imagine I would be doing what I'm doing today if I hadn't [had] that early experience. (Elliot Wheeler)

There were also other examples of turning points in participants' earlier schooling as well as their experiences during university.

During my GCSEs I didn't really have to apply myself too much.... So it was kind of like the feeling of, "Oh OK, I don't really have to do much and I'll get good grades." Then my AS exams [the first part of an A level] came around and very quickly made me realise, "No, I can't just not do anything, I have to actually study." So that was, I guess, like the first of my major learning experiences ... where I didn't do as well as what I was hoping to do in my ASs and then as a result of that I had to really put the nose to the grindstone in Year 13, just to be able to get the grades to

actually go to university. I guess that was quite an interesting learning experience, sort of them knock them down a few pegs if you were.
(Nathan Baker)

For others, turning points occurred during their second year at university. (Study 2 returns to this theme in the next chapter.)

So first year and second year, you know, I plodded along, and did as well as I could. There were points where I struggled. I struggled getting to grips with programming, proper programming, in a lot of ways. ... I ended up, much to my surprise – because I went with not much expectation of really getting into programming – about halfway through my second year, I thought, “This is actually really fun. I quite like this.” So that was quite a *turning point*, again, in what I wanted to do, and what I enjoyed academically at university. It was about halfway through second year, ... when we started learning another language, called Erlang. (Evan Lowe)

In this study, the interviews of the eleven graduates who had taken part in a Year in Industry were coded for turning points using a two-part definition proposed by Enz and Talarico (Enz and Talarico 2016). First, turning points require a change in a person’s life direction. Second, they must refer to a specific episode, rather than an overall period of time.

“Although perceived turning points may consist of several linked events within a temporally extended unit of time (e.g., college or a trip to another country), one must cite specific episodic experiences within the larger time frame in order to create causal links between the turning point and one’s current life direction.” (Enz and Talarico 2016, p.188)

Not everyone experienced the Year in Industry as a turning point. In fact, using this strict definition, there were only two turning points relating to the Year in Industry. Several cases where participants described the entire Year in Industry as a turning point but did not specify a single episodic experience (such as a specific interaction or event) were not coded.

Some participants for whom the Year in Industry was a transition identified limited immediate effects for themselves upon returning to their final year in university.

Interviewer: Did the Year in Industry at [Jalia] influence the way, or change the way, you approached university when you came back?

Respondent: A little. Not much. ... it did influence in ways, but it's a fairly rigid final year, so not so much. (Nicholas Bradley)

I think in terms of learning, the final year at university was really more of the same.... The final year of uni was the same again, really. (Melissa Bryan)

But for participants for whom the Year in Industry was a turning point the effect was considerable. For instance, Nathan Baker spoke elaborately of the effect the Year in Industry had on him. He realised that the practices and theories he had learned at university provided the foundation for the work he was doing on large-scale software applications.

And that is when I really started to enjoy my programming. Because at uni I was by no means one of the good programmers. Like you have got those few guys who have been writing code since they could type, and the first-year projects for them are just a joke. But that [during the Year in

Industry] is when I started to see myself as an actual programmer who could actually code in Java.... (Nathan Baker)

He also approached his final year differently:

So I came back to uni and approached it in a very, very different way. Not only would I go to the lectures, I would sit at the front in the lectures. I would sit there making notes in the lectures. I would also go out and actually do that further reading that they recommended, each week whatever we did in the lectures regardless of the module, I would actually go and read the chapters and all the course books. (Nathan Baker)

Both of these excerpts reflect turning points: they each refer to a specific episode in time and describe a significant change in Nathan's life – towards viewing himself as a programmer and in engaging differently with his course at university. More than that, these turning points are connected to the transition of beginning and returning from his Year in Industry. Enz and Talarico found that these kinds of *transition-linked turning points* are often central to a person's life story (Enz and Talarico 2016). Indeed, Nathan even used the term “turnaround point” to describe his experience.

I think it is quite obvious that the big turnaround point is doing that placement year. (Nathan Baker)

Boundary Objects

A life story is not merely a list of disparate events, it also imposes continuity and coherence (Rosenwald and Ochberg 1992). This reflects its construction by the narrator, as they make connections between individual events. As Rosenwald

and Ochberg write: “The logic with which one event leads into another is not simply “out there,” waiting to be recognized by any disinterested observer. Instead, coherence derives from the tacit assumptions of plausibility that shape the way each story maker weaves the fragmentary episodes of experience into a history” (Rosenwald and Ochberg 1992, p.5). The fragmentary episodes identified here are particularly relevant as storytellers integrate different experiences into their life story. As Ochs and Capps observe: “Narrative activity provides tellers with an opportunity to impose order on otherwise disconnected events, and to create continuity between past, present, and imagined worlds” (Ochs and Capps 1996, p.19). One example of two particularly disconnected events, even disconnected worlds, are the contexts students experience at university and in industry as they begin (and return from) their placement year.

One way narrators construct coherence is through the use of *boundary objects*. For Star and Griesemer, boundary objects mark the intersection of communities and mediate meaning between them (Star and Griesemer 1989). In their example, animal skins act as a bridge between the world of fur trappers and the world of museum curators. By examining the object – the animal skin – the curators can be explicit about the things that they value in it (specific named species, undamaged skins). Looking at the skins with them, the curators’ values are made apparent to the trappers, who usually work to different ends (monetary reward, ease of hunting, edibility). Rather than boundary objects sitting between communities, here, they are carried between communities and carry meaning with them. However, in both constructions, boundary objects are central to the development of coherence across multiple social worlds (Star and Griesemer 1989).

An example of this is the interview with David Bruce in which he describes his experience at university before discussing his Year in Industry. With the

exception of a brief reference earlier in the conversation, this is the first time he mentions his placement year in detail.

... [at the University] there was a room ... that was the Unix lab. You could get your Unix login and go and log in up there. [There was] this thing which was actually really cool. It was like a thin client thing where you just had this little box.... It would sit vertically next to the desk and there was a keyboard and a display, but it didn't really have any computing power in it itself. All of it was running on a big server somewhere.

The University didn't issue smart cards, but [Jalia] did, and I worked at [Jalia] for a year as a Year in Industry. You had your ID badge which would let you into the building and so on. It had your picture on it, but you put it into the machine and it would bring up your session. You could move it around. ... If you need to go and see somebody over the other side of the building, you can pull out your card and walk over there.
(David Bruce)

The smart card here is an object that moves between university and Year in Industry with different, but related, meanings in the different situations.

With your smart card, if you're going to London the next day, you pull it out ...and you get on the train in the morning and go up to London and put it in the machine in the London office and your session comes back. You can use all of that there. The smart cards would [all] work in the same way. When you got back from your Year in Industry I could do that, and it obviously wouldn't bring back your [Jalia] session but you

could have it in the University. So you could suspend your session and put it back in. (David Bruce)

For David Bruce the talismanic “smart card” does not do the same work in both environments: on returning to university he is not able to use the smart card in the same way, yet it still carries meaning for him, although it is differently expressed in the academic environment. As a boundary object, it accompanies him in both environments and acts as an anchor for one kind of experience within another. His exposure to the infrastructure in the Unix Lab anticipates his experience at Jalia, where he receives his smart card. On his return, he brings his smart card with him: now it does not do the same work, but it echoes his experience on placement year.

Boundary objects do not have to be concrete “things” (Star and Griesemer 1989). While David Bruce’s smart card is an artefact, the daily routine students establish during their Year in Industry was an abstract boundary object.

We worked in different companies, different environments. One of the guys worked in San Francisco in America. We all came back with the same idea. We want the structure so we can enjoy our weekends and we can enjoy the weeknights because we know we have dedicated time to do it in. (Jake Mason)

Upon returning to university, they retained the work patterns from their industrial placements.

We sat and worked nine until five on our [final year] project every weekday. We took weekends off like you would in a real job. It was kind of not wanting to break that routine. (Jake Mason)

For Jake Mason, the work ethic he and his teammates bring back from the Year in Industry is, as they recognise, incongruent with their prior work patterns as students. After their Year in Industry, they deliberately choose to maintain the more highly structured timetable of the work environment.

The next part would be about my final year, group projects, working in a team of people where we have all come back from placement. We have all got this kind of structure that we want to put in. We don't just want to be typical lazy students that will just sit down and work a bit, watch some telly and work a bit. (Jake Mason)

In this way, the time-management practices become a boundary object that the students carry between the two communities; the boundary objects integrate the experiences of one community within another. The boundary objects are exposed through the use of a narrative methodology as “any adequate amount of life stories ought to illuminate the connections among the series of narratives that any informant may construct over the course of a life” (Rosenwald and Ochberg 1992, p.6).

Autobiographic Authority

For students, the Year in Industry often marks a stark contrast to the university experience, as we have seen in the turning points and the boundary objects they carry with them. In taking a Year in Industry, students are exposed to new environments that require them to learn new things. As they encounter the wider disciplinary context of computing in industry, sometimes their sense of what it means to study computing changes. When students return to university after their Year in Industry, they carry their experiences and their new constructions of disciplinary knowledge back with them. This return to the

academic world appears to be a significant quality of the Year in Industry, as the students now know for themselves which experiences are valued in the wider discipline and in industry. They do not have to take academics' word for what is useful and, in this, have newly-won *autobiographic authority*.

For instance, for one student in this study, Nicholas Bradley, the Year in Industry brought exposure that altered his view of the discipline and the courses he took.

I almost certainly chose different courses because of the year [in industry]. ... I realised, "Oh, okay, crap. I don't like databases, but they're not going anywhere, so I should really understand them." (Nicholas Bradley)

This was even apparent in some graduates who did not complete a formal Year in Industry. Taylor Long worked for a company for a year before studying computing at Kent. Looking back at his experience, he says:

I remember my first day at the company when I was literally 18 years old, this guy comes into the office to talk to my new boss, and they had this whole conversation in acronyms, and I didn't understand anything they were talking about. They were talking about TCP/IP and can they ping this packet to this, and I was just like... I thought I knew everything and I knew nothing. It was like a whole foreign language. Yet during that year I started to learn all of that kind of stuff. Just terminology that is used in that particular industry and that technical workplace. Can you teach that or do you have to just experience it? I don't know. I was just lucky. (Taylor Long)

Taylor also indicates that his experience in a placement year before coming to university affected the way he approached learning at university.

Like I say, maybe it's a mind-set thing, but I was definitely more interested in the theoretical aspects of the subject and the more foundational knowledge kind of thing because I knew I had enough experience. ... because I'd already got some practical experience from working, that meant that university, for me, was much more around getting the knowledge into my mind and learning about the space, rather than a skillset thing that I needed for work, because I already had the skillset thing. ... So that definitely changed things. (Taylor Long)

This perspective is similar to Hewner's description of students who have an enjoyment experience and adopt what he calls a "goal-directed approach" to choosing courses: "They often had done research beyond their classes into what was necessary for their long-term goal. They would even take non-required classes that they anticipated disliking, because they believed they would be useful for their goal" (Hewner 2014, p.120). It is this autobiographic authority that is exposed as participants narrate their individual experience.

This form of autobiographic authority may be specific to computing as a discipline (or, more broadly, to vocational subjects which lead directly to professional practice). In a study with psychology students who completed a placement programme at different universities, Auburn identified two linguistic repertoires, one referring to the skills they had developed on placement, the other to how academic staff subsequently perceived and valued those skills (Auburn 2007). For the students in Auburn's study, there was a particularly wide gap between what they experienced in the placement year and their final year at university. He observes: "These two experiences are characterised as very

different and unconnected with one another. Given this separation, the inference is that the learning which occurs during placement has limited value in the academic setting” (Auburn 2007, p.128).

Similar to the Kent graduates, the students in Auburn’s study recognised what they had learned during their placement year. However, they did not feel that they could draw on it upon their return to university. Writing about a particular participant, Auburn notes: “The student has produced a version of his experience in which his return to the final year was a transition across two distinct settings or two realms—the realm of work and the realm of academia—and the experiences in one did not transfer easily to the other” (Auburn 2007, p.128). This does not appear to be the case for students who take a Year in Industry at the University of Kent. While they also return to complete the final year of their degree, both turning points and boundary objects indicate that they have made connections between these two separate experiences.

For the students in Auburn’s study, this disconnect meant that on their return they continued to rely on the academics’ view of what they needed to know: “This [linguistic] repertoire, therefore, constructed a separation between the academic setting and the placement setting, where the adaptation required of the returning students was to adopt a subject position which was deferential to the control exerted by academic staff over the academic environment” (Auburn 2007, p.130). In contrast, the Kent graduates have a different relation to the material presented, as they do not need to rely on staff anymore to authorise what they need to learn – they themselves now have autobiographic authority. This relates to the concept of Accountable Disciplinary Knowledge which describes what is recognised as disciplinary knowledge in a particular context (such as university or industry) and which will be discussed in the following chapter (Stevens et al. 2008).

Conclusion

This chapter, in the context of using a life story approach as a lens to examine gradueness, examined students' experience of a Year in Industry. In doing so, three features emerged that illuminate both students' own conceptions of their education and their construction of gradueness more broadly. The first, turning points, indicates a major shift in a person's life. It would be hard to identify – or experience – turning points outside of storied narrative. The Year in Industry was identified as a transition for everyone, but a turning point for some. The second feature, boundary objects, promotes coherence across social worlds (Star and Griesemer 1989). And as Habermas and Bluck established, coherence is central to the concept of the life story (Habermas and Bluck 2000). The Year in Industry exposes boundary objects as participants carry meaning between the academic and professional workplace. Finally, the third feature, autobiographic authority, captures a part of the Year in Industry experience when students return to university. As one graduate says: "Can you teach that or do you have to just experience it?" (Taylor Long)

From the work presented here, the Year in Industry then seems to be a fertile location for the emergence of turning points, boundary objects, and autobiographic authority. Having identified these constructs in this study, it sensitises us to see them in wider work to characterise gradueness in computing education.

The following chapter now draws on the same data set but uses a different analytic approach to examine expressions of Accountable Disciplinary Knowledge in individual participants' trajectories.

Study 2: A Case-Based Approach

Introduction

“Allowing individual narratives space ... allows us to recognize that if something is happening among a group of people, the same thing is not happening to each person. This is a vital insight for educational research.” (Scutt and Hobson 2013, p.22)

Scutt and Hobson ground their observation in analogy with evidence-based medicine. In medical investigation, it is possible to give the same measured quantity of an active agent to several people and measure the effect. However, as they observe, “a group of people in a classroom are not all getting the same ‘dosage’ of education” (Scutt and Hobson 2013, p.22). This chapter takes an analytic approach that investigates individual participants’ narratives, rather than looking at experiences across the lives of several participants.

As part of a focus on individual trajectories, the data here is (re)presented differently. Exploring a participant’s trajectory requires the audience to get to know the individual. But, as Plummer observes, narratives, and in particular life stories, are often so long that they cannot be published in full (Plummer 2001). And even if they could be included in their entire length, not every minute detail is necessary or of interest for the analysis. The question, then, is what rules to follow when selecting text. Put differently, how much editing is too much? An extreme example comes from Abu-Lughod, who conducted life story interviews with Bedouin women and constructed entirely new narratives around themes based on the conversations and observations she had made (Abu-Lughod 1993). As Plummer writes about her approach, “The words of the women go missing in favour of a coherent social narrative” (Plummer 2001, p.179).

In his work, Plummer describes a continuum (reproduced in Figure 6 below) of different *interpreters*. This reflects “the extent to which the subject’s own world is allowed to stand ‘uncontaminated’” (Plummer 2001, p.179). On one end is the interview participant as the interpreter of their own story. An example of this would be an autobiography, which is completely devoid of any external analysis by a researcher. In the middle of the continuum lie systematic approaches to thematic analysis as part of which researchers describe general themes through paraphrase and short (and edited) segments of transcripts (Mishler 2004b). On the other end of the spectrum lies the researcher as the interpreter, entirely removed from the participant, in what Plummer calls “armchair theory” (Plummer 2001, p.179). Life story approaches must always be grounded in narratives elicited and, as such, cannot be situated on this far end of the spectrum.

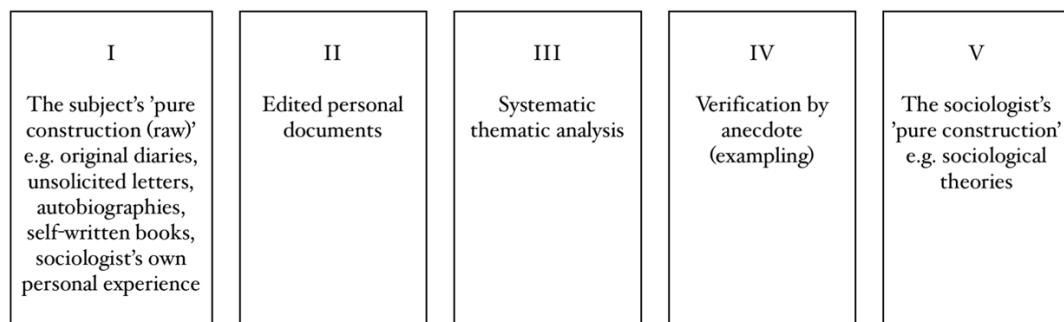


Figure 6: A Continuum of ‘Construction’ (Plummer 2001)

The approach in the previous chapter used individual quotes to support an argument based on several theories, which places it in fourth category of the continuum. In contrast, the work presented in this chapter is situated further towards the left, in the second category of the spectrum. In this category, the researcher aims to keep edits and interventions to a minimum (Plummer 2001), although “some intervention, however, is usually necessary, if only to delete the

(boring) repetition and stammering found in all people's verbal accounts" (Plummer 2001, p.180).

With the shift towards the left side of the continuum, in this chapter the interview process is presented differently from traditional interview research. In the traditional paradigm, questions are seen as stimuli that elicit responses. Researchers work to standardise questions which are then presented to the participant in a structured interview with the aim to reduce interviewer influence and to ensure that all participants receive the questions (that is, the stimulus) in the same way. This, as Mishler observes, "obscures the essence of interviewing – that it is an occasion of two persons speaking to each other – and undercuts the potential and special contribution of interviewing for theoretical understanding of human action and experience" (Mishler 1991, p.vii).

Mishler, Kvale, and others have advocated for a different approach. For them, interviews are a *dialogic process* between interviewer and participant (Holstein and Gubrium 1995; Kvale 1996; Mishler 1991; Walther, Sochacka and Kellam 2013). This new definition sees an interview "as a discourse between speakers" and recognises that "the meanings of questions and responses are contextually grounded and jointly constructed by interviewer and respondent" (Mishler 1991, p.33). Indeed, for Kvale, it is "literally an *inter view*, an inter change of views between two persons conversing about a theme of mutual interest" (Kvale 1996, p.2).

An example of this approach comes from Mishler himself. In his book *Storylines*, he draws on narrative accounts of five craft workers to explore their identity. His main goal is to examine the origin of their engagement with craft work, what it means for them, and the role it plays in their lives (Mishler 2004b). He identifies two main axes – the "large cultural and socioeconomic context of

craftwork within a mass-production, late-stage industrial society” and family relationships – along which his participants’ identities develop (Mishler 2006, p.42).

His approach evolved from an initial research proposal in 1987 to the work presented in *Storylines* (which was published in 2004). In a book chapter from 1996, he describes selecting “those sections where respondents described aspects of their work history” and arranging the episodes in chronological order, “thereby constructing their work-history narratives” (Mishler 1996, p.86). He notes that this represents what Goodman calls the “order of the told” rather than the “order of the telling” (Goodman 1981, p.799). Such a heavy-handed intervention is situated on the right end of the spectrum in Figure 6, where the researcher interprets what is being told.

In contrast, in *Storylines*, Mishler articulates three key aspects of his work, which situate this approach on the left end of the continuum:

- (1) “presentation of and reliance on detailed transcripts of interview excerpts that display their structural features;
- (2) attention to the co-production of accounts through the dialogic exchange between interviewer and respondent;
- (3) a comparative approach to interpreting similarities and differences among respondents’ life stories.” (Mishler 2004b, p.147)

Viewing an interview as a dialogue between reviewer and participant requires the researcher to include detailed transcripts that contain, for instance, opening statements and exchanges with the interviewer that are normally considered outside the purview of the interview (Mishler 2004b). But, for Mishler, it also means using linguistic notation that highlights “structural features”, such as

pauses and utterances, in interview transcripts. An example of this is Gee's linguistic model, on which Mishler relies (Gee 1991). Other researchers often use similar notation but focus on smaller exchanges. For instance, Bamberg examines the positioning of a group of young adolescents in a three-minute excerpt of a conversation (Bamberg 2004). Bamberg calls these kinds of stories – “the ones that are told in mundane encounters and everyday circumstances” (Bamberg 2005) – “small stories”, in contrast to the “big stories” commonly associated with life story methods (Bamberg 2006; Freeman 2006). Big stories are often elicited by asking people to tell their story (as reported in this work) whereas researchers examining small stories are interested in how people talk, “what people *do* with their talk” and “how they accomplish a sense of self when they engage in story-telling talk” (Bamberg 2006, p.142). While the small story perspective makes an important contribution to the field of narrative research, the work in this thesis is more concerned with a macro perspective, with wider trajectories and themes that emerge over time. This chapter thus uses verbatim transcription notation below, but also includes detailed transcripts.

Mishler uses a *case-centred method* to focus on specific aspects of his participants' narratives, such as how they originally became involved in craft work. He explores “similarities and differences among intra-individual or intra-case patterns of change,” rather than across groups of individuals (Mishler 2004b, p.11). This approach is different from traditional qualitative methods of analysis, such as grounded theory, where researchers aim to establish common themes through multiple readings of data, develop coding schemes in the process, and, in some cases, ultimately quantify these themes. Such work – which would be located in the middle of Figure 6 above – typically relies on individual text segments which are coded and presented and does not always preserve the wider trajectories in participants' narratives. In the context of this work, this approach

is problematic since it treats coded responses “as if they were independent of the contexts that produced them” (Mishler 1991, p.4).

By sharing their life story a person is making a series of identity claims. These identity claims are open to interpretation by the audience. Removing them from the wider context of the interview affects the interpretation and allows researchers to overclaim: As Mishler writes, “we are free to fantasize” about who someone is based on small excerpts of an interview (Mishler 2004b, p.22). This removes limits on the interpretation and “allows us to do too much with too little” (Mishler 2004b, p.22). The approach adopted in this chapter – which meets all three of the aspects Mishler identified – is then situated at point A of the narrative quadrant already presented, rather than at point B, which was the focus of work in the previous chapter.

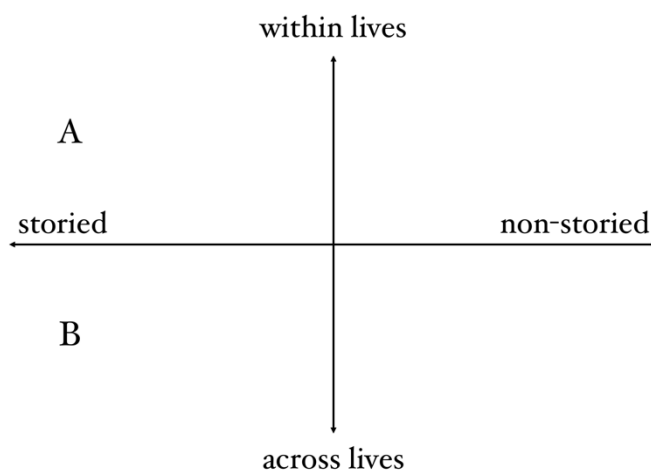


Figure 7: Narrative Approaches Used

“You can’t really separate the educational side of going to university from the social side of going to university.”

The following uses Mishler’s case-centred method to compare and contrast the experience of two pairs of participants and to highlight nuances in individual cases beyond surface similarities. The people whose narratives are examined below are similar and different in ways that reveal something about their experience as students and graduates of the School of Computing at the University of Kent. This section begins with two participants, Jacob Richardson and George Collins. They entered the University of Kent at different times, in 1987 and 1998, respectively, but ended up studying computing at the University for similar reasons. However, this surface similarity ultimately makes room for differences in both their individual experiences and outcomes.

I begin almost at the very beginning of my interview with Jacob Richardson. We have briefly talked about the context and aims of my research. My response focussed on identifying graduate attributes as developed at particular institutions, as well as more broadly my interest in people’s learning experiences and how they think about them. Jacob has just offered that the first chapter of his learning life would likely be the University of Kent, although he briefly touches on his secondary school experience taking A-levels, where little choice was offered about the subjects he studied: “I’m not sure there were any sort of real decisions on my part, really, apart from, broadly, science or not science.”

The excerpt below begins after I have asked him about how and why he chose to study computing at the University of Kent.

Jacob: Initially—I don’t know how the degree is structured anymore—but it used to be that the first year was... it was a computer science degree, but the first year also had a significant electronics engineering component as well. So there was actually a common first year between a lot of the degrees in the School of Computing in those days. I guess the idea there was you might choose to specialise in something different, perhaps, going forward, which I thought was a good idea but in actual fact, it turned out that I hated all the electronic stuff. So it was good to get that exposure. At least I know I have no regrets about not pursuing that.

So, yes, it was a variety of things, sort of circumstances and going to university in Kent would fit in with how I imagined leaving home, but not going too far away. I was never expected to get the—again, I don’t how this is done in schools now—but you were discouraged from applying to, say, Cambridge or Oxford or Imperial College or any of those sort of ones, if you weren’t predicted to get *very* good A-level results. Most people were making applications before they’d finish their A-levels in the UK at that time.

I, for various reasons, was not predicted to do brilliantly and was discouraged from applying to an “elite” university, for want of a different word. In the end, I probably could have applied. There you go. That might well have coloured my initial experiences of going to Kent as well, but having arrived there, if I’d have known at that point what the situation was earlier on, I might have chosen to go somewhere different. I arrived at a university that wasn’t my first choice, having been guided in that direction by people who predicted me to do worse than I actually did. I think that would be starting on a lower note, perhaps.

Sebastian: Possibly slightly sour.

Jacob: I would think that that's not an unreasonable description of how it arrived.

(omitted discussion of how he became interested in computing)

In terms of selecting degrees and stuff, I really didn't know what else I wanted to do. University was just this thing people went to and I didn't really have a great idea about what actually went on there. If I'd have chosen a mathematics degree, I have no idea what that might have entailed, so doing computing had some element of familiarity as well.

Jacob describes his experience of taking electronics requirements during the first year at the University. Here, his expression "At least I have no regrets about not pursuing that [electronics]." alludes to the fact that he may, however, have other regrets – a theme he revisits when we discuss his initial experiences on campus. Similarly, when he describes the "elite" universities he could have applied to, the addendum "there you go." may indicate that he has come to terms with these circumstances. We also learn that for him "university was just this thing people went to" – attending university may have been expected of him, and he had some prior experience and familiarity with computing, which informed his degree choice.

Outside of this excerpt, Jacob characterises his experience in secondary education as a sort of *preface* to his time at Kent. Up until this point, we have not yet talked extensively about his university experience and I was interested in how his experience choosing Kent affected his experience at the University.

Here, we initially talk about his encounters with other students in the programme on campus, as well as his first reactions to his modules.

Sebastian: That brings us to university. I guess I'm interested in whether there are any experiences there that stand out to you and also I imagine the way you learn was perhaps different from how it was before university?

Jacob: Yes. That's certainly true. You can't really separate the educational side of going to university from the social side of going to university. I found, when I arrived at Kent at that time in '87, that the people, most of my fellow students, I didn't feel particularly like I had much in common with them at the time.

The first two semesters or terms, or whatever they call it these days, I absolutely hated the place and I was seriously considering just packing in and finding a job. I thought some of the introductory courses that we were studying were kind of trivial. There didn't seem to be a great deal of...¹² Everyone's got this big thing about university and you're all studying and learning on your own, but the actual coursework seemed to be fairly easy to get through. I was expecting a challenge and didn't really find it.

As I say, I went to this university away from school. Out of my school, there's only half a dozen or so people that actually went on to university

¹² In accordance with Mishler's approach to the presentation of interviews, the interviews in this chapter were not edited for readability. While "..." in the previous chapters refers to an omission, it indicates in the extended quotes here that the participant was trailing off.

at that time. So I felt a little bit out of place for a while. That makes it hard as well. If you don't feel part of a university, I think it becomes hard to really engage with it, the educational side of things, because this university is your whole life now when you go and it takes over.

So I found that hard. That's the sort of initial experience I had of university, which is, essentially, not a hugely positive one. I'm thinking that towards the end of the first year, I was very much deciding whether or not to stay. But I did, and certainly things got better. So if you were going to draw another line there, there was like this sort of learning and acclimatisation and then as the work got more interesting and you finally settle down there... So I was happier when I moved out of college and into a house with my mates and things like that. (Laughter) That helped a lot. The real turning point, I think, would be in the second year when we started doing basically more interesting work, getting onto the more interesting and more the stuff that was new to me. There was one... I don't know if he's still there. Is [Thomas Nolan] still...?

Sebastian: Yes. Yes, of course.

(omitted details of course taught by specific lecturer)

Jacob: It might sound a bit of a cliché, but it's finding a teacher at that point who is teaching something interesting and [Thomas Nolan] always seemed to be available to people if you wanted to discuss the coursework or had any sort of discussion about that. I think perhaps he was kind of happy to finally have some students who were interested in his stuff because that functional programming course, I'm not sure if that was one of the more popular ones, I think people were just hoping they'd get

straight into programming PCs or whatever, writing games or programmes for Windows. That was when I finally found an area where I could develop an academic interest in the work.

Sebastian: That makes sense and it's an important part of university, figuring out where you fit. Would that be a separate chapter, this second year experience? Or would you integrate that together with the third year?

Jacob: I think it would be... It's certainly a significant point because it was the point at which I decided that it did make a change in the way I viewed my learning career, I think, that you could find stuff that was interesting and pursue it to your own benefit and improvement and enjoyment. I don't know if it's an entire chapter of stuff, but it would certainly be the significant part of. It would certainly be the start of a new chapter, if you see what I mean, because it was at that point there was that change and finding that area that I was interested in, and being taught about the theoretical aspects of computer science, which is where I carried on. I went on to do a PhD in related areas, so yes, that certainly formed the basis of the completing of the degree and carrying on through postgraduate studies.

Sebastian: I didn't expect you necessarily to say that because... I was surprised when you talked about a PhD just now because it sounded like university in the first year didn't feel quite right, so things must have improved quite markedly or significantly.

Jacob: Yes. I found work that I was interested in, which makes it much easier to be committed to it. What would the cliché be? 'Finding yourself'

or something along those lines. If you wanted clichés for a chapter title for this story, maybe that would be an interesting psychological experiment. But it was a complete sea change. Beforehand, it was just like, well, this is something that I'd been told to do, effectively. Either that or get a job. It sort of defined where I carried on through my advanced studies.

We learn that when he arrived at university, Jacob's initial experience was largely negative, as he did not find that he had much in common with the other students in the programme. He even considered dropping out when the early courses did not prove to be a challenge. He says that he "absolutely hated the place and I was seriously considering just packing in and finding a job."

However, in a surprising turn, things improved for Jacob. This, for him, is connected to moving off-campus with his friends after the first year (as almost all students at the University of Kent do), but is also strongly linked to finding and learning advanced disciplinary aspects of computing that he was more interested in. The social and educational sides of life can be aligned or misaligned, as he says, "if you don't feel part of a university, it becomes hard to really engage with the educational side of things". This marks the beginning of a new chapter of this learning life, as he draws a "line" from his prior experience. This appears to be a *transition-linked turning point*, which, as we have seen in the previous chapter, often forms a particularly significant aspect of an individual's life story (Enz and Talarico 2016). Jacob talks about this experience as the beginning of a new chapter of his learning life and even explicitly calls it a turning point. Despite this positive development, I was initially surprised that he pursued a PhD after graduation and I express that in the interview. For Jacob, this experience is not only a turning point but also a redemption

narrative, in which a negative experience turns positive in the end (McAdams et al. 2001).

The experience of a second student, George Collins, stands beside this. For George, too, university was simply the next step in the educational journey that students like him were expected to take, “my reasons for going to university weren’t primarily because I want to get a job that requires this degree or because I want to do this degree because it’s really interesting, it’s because that’s what would be expected of somebody in my position. Right there, there’s the seed of the whole back story as to where my motivation was—or indeed wasn’t.”

George entered the University after spending two years working in a library whilst at the same time working to complete a mathematics A-level through evening classes, as he had chosen other A-levels – physics, music, and design technology¹³ – as part of his secondary education. Similarly to Jacob, he had a negative experience when he arrived at university. This part of our conversation begins after we have talked about his secondary school experience and the path he took to university.

George: Yes, one afternoon in the summer of 1998 I discovered I was going to university at Kent. In due course I found I’d been allocated to Keynes College and I could get a room in Keynes College. When I got there, pretty quickly I was rather disheartened to find that I was sharing

¹³ In 2013, the national curriculum in England described design and technology courses as follows: “Using creativity and imagination, pupils design and make products that solve real and relevant problems within a variety of contexts, considering their own and others’ needs, wants and values. They acquire a broad range of subject knowledge and draw on disciplines such as mathematics, science, engineering, computing and art” (Department for Education 2013).

a single-sex corridor, full of yobbos basically, and completely overlooking the bar—to the extent that it was impossible for me to hear myself talk in my own room at any time during the evening at all because of the noise from the bar. The guys in my corridor were extremely disruptive.

I mean there were 15 fire alarms each term, most of those set off in the middle of the night by people in my corridor who were—I mean I'm sure drugs are part of university anyway for a lot of people—but the way they did it was fairly unpleasant. There was just a lot of disruptive behaviour, a lot of noise. It was the last year that we had porters at the colleges and the porters were absolutely run ragged trying to deal with this particular corridor.

(omitted further discussion of accommodation issues)

A lot of damage had been done, in terms of my even feeling like bothering with going to lectures, and just my self-esteem in general. Now it wouldn't be fair for me to blame my failure to learn just on the people in my corridor, but it was part of the environment that I was in which conspired to help make it harder for me to learn.

I mean, I think my course had eight modules, something like that. You'll forgive me for naming names and it doesn't have to go on the transcript if you don't want but there was object-oriented programming with Java, with [Joshua Fraser], which was a double module. He was really good. I didn't follow everything he said but I was very aware that by turning up to his lectures, I stood a good chance of learning something and that the lecture notes would be on the web.

He was very accessible if I wanted to ask stuff afterwards. I think the text book that we had that went with the course as well was good. It also was probably closest to stuff that I was actually expecting the course to be. There were actual building blocks of programming there. My previous years of playing with shell scripts and stuff, it didn't seem a million miles away from some of that.

There were some other courses taught by certain other people where a combination of the material and the way it was taught left me extremely cold; somebody talking to me in a lecture about address buses on a 386 chip. Now, I know it was about that because he said "address bus" a lot, but I really didn't understand anything beyond that.

That's the other thing and it's just coming back to me. In the first few weeks everything was so simple. It was like, "Here is a computer and this is what the keyboard looks like. This is how you operate a mouse." I was thinking, "Yes." "Demonstrate that you are capable of sending a message to the UKC.courses1 newsgroup."

Okay, well I'd been using newsgroups a lot for the last two years. It was one of my guilty pleasures so I had no problem with that. For the first couple of weeks I was thinking, "I presume this is going to get serious at some point because this all looks incredibly simple." It's not that I'm not keeping up, it's that I'm wondering what I'm missing.

Then, suddenly—it was a few weeks in—suddenly, it had all gone into warp speed and I was getting left behind. It was if I had missed a whole load of stuff, but I don't think I had. I still don't really understand what happened. Sadly, what I also found was that I didn't have the motivation

to try and catch up with stuff that I didn't understand right from the word go.

I mean I thought that going to university, really it should be the making of me. It should be time when I get to meet lots of people my own age outside of school and get to meet women and get to be a grownup. Instead I was incarcerated with a load of kids, a load of boys, who were behaving extremely childishly and who were drunk or stoned most of the time.

I found solace in the music, which has no department at the University of course. There was a lot of music stuff that I could be involved in—the choir, and the orchestra, and stuff like that. That was really what kept me there.

Similarly to Jacob, George had some prior computing experience, such as “playing with shell scripts”. And he found some material that matched his expectations of studying computing at university: “There were actual building blocks of programming there.” However, there were other courses that left him “extremely cold”. And when he finds himself surprised as the course accelerates, he does not have the motivation to catch up. This is brought to light by an approach focussed on individual trajectories, as we need to see his expression that he “thought that going to university, really, it should be the making of me” in the context of his prior experience, of taking his math A-level, at night, over several years. So while his origin story about going to university and aspects of his experience after arriving on campus in some way parallel Jacob, George ultimately took a different path and eventually left the University.

We resume the interview with George as we talk briefly about his experience in the second year, when he moved off-campus where his accommodation environment improved but he also felt more isolated.

George: In my second year I was not living on campus, I was living in a basement flat in [Old Chapel Road], which was very much more to my liking. I had space that was actually mine and I felt more like a grownup again. I was more isolated from everyone else. It was a little bit more of a motivational hill as well as a physical hill to climb in order to actually go and attend anything.

Initially I'm sure I started off with good intentions but a few things happened along the way. I'd become more and more disinterested in my course and I had become more and more interested in the railway. In particular the London Underground which had become a source of fascination with me to the point where I knew that at some point I was going to have to go and work there.

Then, through the winter, I got depressed and I found it very easy to stay in my basement flat, which was dark, being a bit of a basement as well. I found I was sleeping most of the day as well as most of the night. Yes, it all wasn't working for me. In about February or March I remember having a phone call with my mum and we realised that basically it was the end of the road as far as my course was concerned and there was no point trying to continue.

(omitted seeing tutor to communicate decision to leave the University)

Sebastian: I was going to ask about that, do you feel that—I think regret is maybe too strong of a word—but as you were saying, if it wasn't for you at that time, looking back now, do you think that leaving was the right decision for you, I guess?

George: By the time I'd actually dropped out of my course in February or March of my second year, it was the only sensible option. I did look at the possibility of switching to a completely different course or something else like that but I thought, "I've been in formal education for a long time now and it's been getting worse not better. Maybe it's time to go and do something completely different with my life." I didn't like the idea of trying to look round for something else to do.

I mean the whole thing of going to university, the whole decision process about going to university was ultimately based on a belief, an automatic assumption that university is where people like me must go. It wasn't really based on I want to learn this course because I'm in love with this course and because this is what I want to do with my life, it was just people like me go to university so let's look round and find a university that will accept me doing a course that I might enjoy. That was actually the process.

Well maybe people like me shouldn't necessarily have gone to university. I mean I am actually glad that I did but not really for the computing aspect, more for the social aspect and in particular the musical activities that I took part in. I would love to look back on a different history in which I had gone to university and I'd done a course that I did get on with. Or that I'd done that course and I'd somehow been more inspired

by it, maybe I had been better at seeking help when I needed it, that I'd got through it and that I had a degree at the end of it.

I still have no idea what I would have done with a degree at the end of it. It might have helped open a few other doors maybe but I wouldn't say I have no regrets. I don't really see how it would have turned out very differently.

In contrast to Jacob's redemptive experience, this may be a contamination sequence, where an initially positive experience turns negative (McAdams et al. 2001). While the expectations about university life were at first not fulfilled for either of them, for George it led to him leaving the University. George's narrative illuminates the nature of his university experience particularly well, yet it was not a planned addition. Participants were recruited through the University's alumni office and this was somebody who was *not* a graduate who responded to the interview request.

Both accounts also reveal expectations (or a lack thereof) about life at university. And for both Jacob and George these expectations were a compound of social and intellectual issues.

For Jacob, going to Kent "fit in with how I imagined leaving home", and in that he was following a familiar path, although not a path that many of his contemporaries trod, "out of my school, there's only half a dozen or so people that actually went on to university at that time". When he arrived he "didn't feel particularly like I had much in common" with his fellow students, perhaps because of different social backgrounds, or, as he might have been expected to apply to a more prestigious university with higher entry requirements – indeed, he believes that he should have been so advised – the lack of fit might be

because students at Kent burned less brightly, with different interests and attitudes to his own. Alongside these feelings of social unease, he also experiences disillusionment at the kind and quality of work that his course demanded. He found some of the first-year modules “kind of trivial” and not at all the sort of thing he expected to be studying, or that he wanted to be studying “I was expecting a challenge and didn’t really find it.” And when Jacob does “find his feet” in his second year, again we see the two aspects intertwined. He finds an area to be passionate about, with a sympathetic teacher who was “happy to finally have some students who were interested in his stuff” and at the same time “I was happier when I moved out of college and into a house with my mates”.

George’s journey was different, he did not come straight from school, but from a job during which time he had been studying for a Maths A-level at night school. Nevertheless, for him it was an “automatic assumption that university is where people like me must go”, although his primary reason for going to university is not learning, or gaining mastery in a subject, but to be a time “when I get to meet women and get to be a grownup”, and these two aspects are clearly related. Through ill chance he is allocated a college room on a “single-sex corridor ... completely overlooking the bar”. While his description of students’ excess is familiar from caricature and frat-house movies, and while he accepts that “drugs are part of university anyway for a lot of people”, this was not an attractive atmosphere for him, and the expression of his disillusionment is visceral: “I was incarcerated with a load of kids, a load of boys”. Indeed, he does not identify with computing students as a whole, but, as he says, eventually “found solace in the music”. With an initial sense of *is that all there is?* (a reaction similar to Jacob’s) he finds the work straightforward, and says, “It’s not that I’m not keeping up, it’s that I’m wondering what I’m missing”. He is, though, a very different learner from Jacob. He has little passion for the subject, and *how* he is taught is important to his learning: “I didn’t follow everything he said but I was

very aware that by turning up to his lectures, I stood a good chance of learning something.” And when the work stops being straightforward, he withdraws from it, socially and physically, “sleeping most of the day as well as most of the night”. When it comes to formally withdrawing he doesn’t talk with anyone at university before ultimately contacting his tutor, but from his previous life: “I remember having a phone call with my mum and we realised that basically it was the end of the road”.

We see from these cases that “learning trajectories” are not single-issue constructs, but a closely woven collection of social and educational concerns. If Jacob had gone to a university where he had immediately felt “at home”, or if George had found himself on a quiet, mixed-sex corridor, their learning lives would have been different. And although both their stories are woven from social and educational strands, they are not equally strong. For Jacob, the intellectual adventure is more prominent, with his eventually proceeding to a PhD; for George, university is more of a cultural experience, to grow and develop as a person.

“An over-riding sense of disappointment as well, because I had been so interested in computing, and then to go to university and think, ‘I don’t like it.’”

The previous section explored students’ learning trajectories through the lens of social and intellectual experiences on campus. Another aspect of the student experience is the acquisition of disciplinary knowledge.

Students have different reactions to the courses they encounter as part of their university education. Some of these responses are well explored in the literature, and familiar to academics. For example, in work by Hewner and Guzdial on

student attitudes towards computing, one student says: “I really didn’t like any of the cs classes I took in college. They taught me a useless fake program called Dr. Scheme. All I really learned was cs theory” (Hewner and Guzdial 2008, p.76). Ko found in his study of informatics students’ autobiographies that while many had positive experiences with programming before attending university, their initial experiences of computing at university were negative and described the discipline as “cold, rigid, ... and divorced from any relevance to people and society” (Ko 2009, p.67). And in a study of engineering students by Ulriksen et al., when asked why he should learn mathematics one student responds: “I don’t know. I’ve tried to ask, but nobody really seems to know it. They say all engineers just need maths. ... They just say: You just need to have maths because it’s so basic in our world, our technology. You need maths in everything, so they just want you to take it in case you are going to use it someday” (Ulriksen, Holmegaard and Madsen 2013, p.314).

These are expressions of what Stevens et al. call *Accountable Disciplinary Knowledge (ADK)*. ADK describes what is taken as disciplinary knowledge in a particular context (Stevens et al. 2008). As Stevens et al. observe, “distinctly different forms of knowledge are *counted* as disciplinary knowledge in different situations, at different times, and by different people (Hall and Stevens 1995; McDermott and Webber 1998; Stevens 2000; Stevens and Hall 1998).” [emphasis in original] (Stevens et al. 2008, p.356) For instance, the activities that demonstrate computing knowledge in a first-year computing curriculum (such as passing exams in a mathematics course) tend to differ significantly from real-world computing tasks.

ADK is often exposed through the tension it creates, for example when students complain that the work they have been assigned does not seem relevant to the subject they have chosen. Ulriksen et al. describe this as a “gap between

expectancies and experiences” (Ulriksen, Holmegaard and Madsen 2013, p.310). In their study with a cohort of engineering students, all students experienced a gap in some form (Holmegaard, Madsen and Ulriksen 2016). There are similar responses to the computing curriculum at the University of Kent in participants’ narratives.

For Stevens et al., Accountable Disciplinary Knowledge is part of a framework of *student becoming* which they developed using data collected as part of the longitudinal and ethnographic *Academic Pathways Study* (Stevens et al. 2008). This study was conducted at four institutions in the United States where researchers followed students in engineering over four years from their first year to their senior year. The authors examine how students “become engineers” as they undertake and experience their engineering education (Stevens et al. 2008).

Stevens et al. identify three interrelated dimensions of engineering learning (Stevens et al. 2008):

- (1) Accountable Disciplinary Knowledge describes what is counted as disciplinary knowledge in a particular context.
- (2) Identification refers to whether and how somebody views themselves as an engineer, as well as how others view them.
- (3) Navigation refers to students’ progression through the pathways that lead them to become both interested in engineering and ultimately recognized as an engineer. This aspect of the framework is particularly relevant in the United States, where the *Academic Pathways Study* was conducted. Depending on the institution, American students may have to pass through several stages, such as making additional application for admission to the engineering program and a major (degree) declaration. Navigation also includes other aspects, such as students’ ways into the

discipline as well as the completion of required courses and examinations at the end of term.

McCartney and Sanders have since then used this framework in a longitudinal study with American computing students and observed shifts in ADK, how students constructed their professional identities as they moved towards the job market, and the navigation of university and internships (McCartney and Sanders 2015).

In their work, Stevens et al. focus on students' experiences at university (Stevens et al. 2008). However, more recently, researchers have conducted work on students' transition from university into employment in different disciplines, including computing, political science, psychology, and engineering (Begel and Simon 2008; Dahlgren et al. 2006; Davis, Vinson and Stevens 2017; Jungert 2011; Vinson, Davis and Stevens 2017; Vinson and Stevens 2016). Indeed, as Begel and Simon observe, "Software developers begin a transition from novice to expert at least twice in their careers – once in their first year of university computer science, and second when they start their first industrial job" (Begel and Simon 2008, p.3). We have seen a form of this in the previous chapter when students who take a Year in Industry experience a different construction of disciplinary knowledge in the workforce and, sometimes, carry this with them when they return to university. However, for students who are starting a job after graduation for the first time, what is "counted" as disciplinary knowledge differs from the activities they have come to recognize from university. The following explores graduates' longitudinal learning experiences both upon entering university education and after graduation.

Here, I examine the accounts of two students, Elliot Wheeler and Henry Summers, who graduated in 2000 and 1999 respectively and whose narratives

reveal different expressions of ADK. Neither of them completed a Year in Industry, which was less common when they entered the University. Elliot took a non-traditional path to the University of Kent, as he originally started a Physics degree at a red brick university,¹⁴ but left after his first year.¹⁵

I begin with an exchange early on in the interview with Elliot Wheeler, after we have discussed the first chapter in his learning life, which he identified as his time at school.

Elliot: Then, the next chapter would be quite short because I left school and went straight to [the red brick university] to study Physics. I had a lot of fun, but, after one year I left. It was probably not an altogether uncommon disaster story. I spent too long in the bar and not enough time working. It was just not going to work out right. Looking back, it was a catastrophe at the time, but it was also part of what has taken me on the path that I've followed. I wouldn't be a software engineer if I'd got myself a degree in Physics. Probably not. That's quite a short chapter, and perhaps not relevant to what you're interested in.

Sebastian: Do you mind if I ask a question or two about that?

Elliot: Absolutely. Go ahead.

¹⁴ The term "red brick" university refers to institutions that were founded in the late 19th and early 20th century in major cities in the UK.

¹⁵ This was not an unusual path for participants, as two other people, Benjamin Holland and Jordan Parker, also dropped out of another university before coming to Kent. They both attended a "plate glass" university, a name for the group of universities established in the late 1950s and early 1960s, including the University of Kent.

Sebastian: Why did you choose Physics, in a sense? It sounds like you were quite interested in computers, but then you didn't have the A-Level experience. Was Physics another one of the courses you did well in, so you wanted to pursue that? How did that come about?

Elliot: Physics was a subject that I did well in. I enjoyed it. At the time, there wasn't such an obvious curriculum at university for Computing. Sure, places offered that sort of thing, but it wasn't one of the more mainstream subjects, as it today. It wasn't such an obvious choice to take, and I also didn't have a clear picture at the time of what career I would follow. I was choosing a university subject just based on what I was apparently good at at school rather than what would lead me to a career direction.

Sebastian: Okay, that makes sense. Then, the second question I have is centring around your experience at [the red brick university].

When you say it didn't quite work out, was that a purely personal thing that you just spent too much time at the bar, perhaps the way the course was structured didn't work for you, or you figured that, actually, Physics wasn't quite what you were going into? Was it just the first thing?

Elliot: No, it was just going down the bar.

Sebastian: Okay. (Laughter)

Elliot: Yes, it's as simple as that. You're young and given all that freedom. As I say, it was a lot of fun, but I didn't do much work, to be honest. The course, its structure and the tuition were irrelevant.

Sebastian: It just occurred to me that I need to ask one more question about the previous chapter. I'm asking everybody for these chapters and I'm also asking if you can come up with a title for each chapter to describe how you think about it or how you feel about it. Do you have a title in mind for both the schooling chapter - the earlier schooling - and then [the red brick university]?

Elliot: Not really. No, I haven't thought of any chapters, honestly.

Sebastian: That's alright. Then, you said you left after your first year at [the red brick university]?

Elliot: Exactly, yes.

Sebastian: Then, you went to Kent? Is that right?

Elliot: Not at all, no. I had my Adrian Mole wilderness years.¹⁶ (Laughter)
God, when did I go to Kent? I went to Kent when I was about 28.

Sebastian: Oh, wow. Okay.

Here, we see another rationale for choosing a course at university, as Elliot describes physics as a subject that he "did well in". However, he also talks of spending too much time socialising "in the bar" – and not enough time on his

¹⁶ The Adrian Mole wilderness years refer to the fourth book in a book series by Sue Townsend (Townsend 1993). It covers the life of the protagonist Adrian Albert Mole, from age 13 onwards, and is written in the form of a diary.

studies – during his time at the red brick university. And while he says that it was “a catastrophe at the time”, he also attributes the path he has subsequently followed to this development. This is, then, an expression of the *double arrow of time* in narratives. As Mishler writes: “Constructed retrospectively, by looking backward from the present, their [stories’] plots are “governed as a whole” by their ways of ending, that is, by the current situation in which tellers find themselves after what has happened to them in the past” (Mishler 2006, p.36).

I was taken aback that Elliot also was not inclined to identify any chapter titles at this point (as it had been included in the prompt), but decided not to press him on it at this point. In the following, his path took – for me – an unexpected turn that reveals my own assumptions as an interviewer when he did not immediately enrol at the University of Kent after leaving the red brick university. This was one of the last interviews I conducted, so I had been exposed to the accounts of a significant number of graduates in the weeks leading up to it. Elliot’s story diverges from the master narrative I had unconsciously internalised, of students who complete their A-levels and then immediately enrol in a computing course at the University of Kent (or do so after briefly spending time at another institution) (Andrews 2004; Hammack 2008; McLean and Syed 2015). Instead, Elliot went to work for several years before returning to university.

Elliot spent six years in the Civil Service, then began to take evening classes as he was “trying to find some sort of direction” and completed an accounting A-level. When his partner was able to support both of them, he decided to return to university at the age of 28. He considered studying accounting, but returned to computing as a subject, which had become more common than it was when he first entered university.

At this point in the interview, we have briefly talked about his time at Kent and his final year project with a company for which he had been working in the previous summer vacations. After graduation, he initially returned to this company for a year, before moving to a different employer.

Sebastian: I don't know how much you remember from your earlier schooling experiences, but I assume university was quite different at that point for you. Are there any things that stand out there?

Elliot: Well, I would say my approach to university was very much influenced by my experience of [the red brick university], in that I was absolutely determined that having got this second chance, I wasn't going to mess it up.

I worked fairly hard, and I got a first and a prize for the best examination results in the year. There was no messing about. It was pretty focused. That was probably a good thing.

Some people say that they're not really looking for that sort of top-level qualification because they feel it would reflect some nerdiness, but my experience is that's not true. I think people do look at that and think, "Well, obviously, this person is moderately smart and has worked fairly hard." I think it's of benefit to have done that.

Again, if you're looking at the big picture, "Well, what would have happened if I'd gone to study Computing and not messed about quite so much when I left school?" maybe I would have got a 2:1, a 2:2 or something. Would I be in the same position? Maybe. Maybe not. Who knows? Certainly, everything leads to your current position, doesn't it?

Sebastian: Yes.

Elliot: There's a bit of a 'butterfly effect': you change one thing from the past and the future may not be the same.

In this exchange, Elliot explains how his experience at the red brick university influenced his time at Kent. For him, it was a "second chance" that he "wasn't going to mess up" and so he worked hard to achieve a good result. We do not get an explicit answer to whether he thinks he would have ended up in the same position – in computing – if he had continued with his studies at the red brick university, although it seems clear that he worked harder at Kent as a result of this experience.

Elliot: Well, the next chapter - and probably the final chapter - would be 'learning during career'. What have I done? I'm on my third job since leaving that first company, so the fourth job after university. Really, I would say that with learning during my career, the one thing that I've thought about (relevant to this) is that changing a job is the biggest driver for learning something new.

For example, I went from my first job, where I was for a year and I was working in Java, I went to the next job and I was working mostly in Visual Basic. That wasn't too difficult a change because I had some very much earlier experience in BASIC.

Visual Basic is very different, so there was quite a learning curve when I joined that position, but there were other things as well. There was some web development - I think that was in PHP, as I remember - and also

some stuff to do with Integrated Business Systems. All of these things are stuff that you learn and you have quite a steep learning curve going into that new job.

Then, when I changed again from that company, and I think I was there for maybe six or seven years, that's when I went to [Scandinavia], where I am now. There, I started working in C#. Shortly, after I went there, they started moving towards Agile development, which was a big thing happening in the industry at the time. They're probably the biggest things that I learnt there.

Then, I've recently moved - less than a year ago - to another job, again in [Scandinavia]. Here, for example, I'm learning new things again, where we have a fairly heavy focus on unit testing, talking about test-driven development, and things like that. Yes, I would say the biggest driver is changing jobs.

I'm going to say that that's also a driver to change jobs. For example, if I've been at a job for six or seven years, then one of the biggest drivers for changing is the feeling that perhaps you're not learning anything new.

Not so much to move and perhaps get a pay rise or something like that, but just a driver for change, I would say.

Sebastian: Yes, I think that makes sense. Continued growth in some way?

Elliot: Yes.

Sebastian: When you talked about moving jobs and you faced that steep learning curve, with picking those new things up, is that something that came easily to you? Is that something that was supported by mentoring, certain educational materials or taking courses? Is that something that you would say university prepared you for? I'm interested in how that looks when you pick up a new skill.

Elliot: Generally, there's very little support. It's, "Here's our software project. I'd like you to start working on that." You literally look at that and think, "Well, okay, I'm looking at a project with 100,000 lines of code in a language I don't know." Yes, it can be a little tough. (Laughter)

My experience is that people don't expect you to hit the ground running that fast, so as the new guy, people are happy to cut you a bit of slack. Generally, you need to figure it out for yourself. Sure, you talk to other people who work on stuff, but you can't bug them all the time over the basic stuff. You just have to engage yourself with the project and the skills that you need.

Here, Elliot goes along with the chapter structure without any prompting and identifies the theme of changing jobs as "the biggest driver" for learning new disciplinary knowledge. He describes how he moves to a different position every five to ten years and talks about the learning curve he experiences in different companies when learning technologies that were previously unfamiliar to him. The material is not always about technologies, but also includes development processes, such as the introduction of Agile and unit testing. In his experience these technologies and skills are what employers simply expect their employees to learn, know, and use.

I was interested in his experience learning new skills. Elliot describes having “very little support” and having to figure things out himself. Working with large code bases, such as the “100,000 lines of code in a language I don’t know”, was also a theme for students who completed a Year in Industry, as reported in the previous chapter. And this is not confined to this research. Finding the appropriate balance between asking colleagues and having to “figure it out for yourself” is something Begel and Simon identify in their study of programming novices during their first months at Microsoft (Begel and Simon 2008).

As we approach the end of the interview, Elliot brings up further thoughts on the computing curriculum he experienced at university. This was to my surprise, as I had feared my earlier assumptions and his initial reluctance to follow the chapter structure may have coloured the interview and closed off potential avenues of conversation.

Sebastian: Then, I have left to ask whether there is anything else that we haven’t talked about or that you think I should know about.

Elliot: I think we’ve covered most things. I was interested whether you would want to know about the relevance of the curriculum at Kent to working in the real world.

Sebastian: If you have thoughts on that, sure, yes.

Elliot: I do have thoughts on that. My first thought, when going to do real jobs as a graduate, is that a surprising amount of what you learn - or what I learnt at university at that time - is actually irrelevant. That was my thought at the time, and I distinctly remember having that thought.

You learn a lot of stuff about logic. I remember we did a module on assembly language. There was a lot of stuff on processor architectures. I made a few notes, actually. What did I have?

There was a lot of stuff on functional programming, computational theory and, also, a lot of theoretical stuff. There was the parallel programming, compiler techniques, expert systems, and some artificial intelligence stuff. Seriously, some people will use some of that stuff. Most people will use none of that stuff.

That was my first thought about it. If I spent three years learning all the stuff that was going to be directly relevant to being a software engineer, I think I could come out of university with a much stronger arsenal of equipment and a deeper foundation.

Looking back, I would say I have a slightly different view on it now. That is that I think university is probably all about giving you the breadth of knowledge that you perhaps wouldn't get if you'd focused on what you might call 'depth' in terms of giving you the detailed training that you need to be a software engineer.

You could have gone into a lot more detail in terms of real-world development and actual programming challenges rather than smaller tasks to support the theoretical concepts that were being taught and so on. Looking back now, I think that learning about parallel programming is something that's been heavily added on to the .NET Framework, for example, recently. Having studied that at university, I think I am wiser and richer for having had that studying experience now that parallel programming is becoming more mainstream.

Also, I think some of the electronics courses about processor architecture, assembly language and even some machine code are useful for how you think about the efficiency of programming. Now that we've so heavily abstracted away to programming within managed environments - all the .NET stuff - you tend to lose sight of what it means to code something efficiently. You have more of an insight through having studied the low-level mechanics of how a computer works.

Yes, I think it was worthwhile. I just wanted to tell you those things. I'm a less harsh critic of the curriculum now than I was when I left.

Sebastian: Is that as a result of your career that you have gotten perspectives that support that view that you just talked about or is that you've just gotten wiser, in a sense?

Elliot: I think it's difficult to say. They say you get wiser as you get older, but I wouldn't like to guarantee that. (Laughter)

My perspective now is that an employer is really going to give you the experience, or your job is going to give you the experience, which is equivalent to getting that in-depth training that I was looking for as a graduate. You're going to get that anyway, but an employer is never going to give you that breadth of experience. Unless you're actually working in neural networks, for example, you're not going to study neural networks. You're not going to learn anything about them.

Elliot initially did not find the content covered as part of his computing education at Kent useful. Again, in this, we see an expression of Accountable Disciplinary Knowledge in that the material that Elliot describes is what the University, the School of Computing, and its faculty have deemed necessary to “become”, and to graduate as, a computer scientist. Later, Elliot explains that any employer “is going to give you the experience”. This is another expression of ADK, in that the employer will hold him “accountable” to certain disciplinary knowledge that he is expected to learn.

The argument that a course exclusively focussed on software engineering may have left Elliot more equipped for the challenges in the workforce is not unfamiliar – and, indeed, one factor in the recent emergence of coding bootcamps (Thayer and Ko 2017). However, in hindsight, Elliot’s view has changed and he is now a “less harsh critic” of the curriculum. He views his university education in computing as a way of gaining a “breadth of knowledge”. Through his own experience, he can now see the principles informing the material he was taught – which seemed “irrelevant” at the time – are used in mainstream software engineering. This point was important to him, and is freely offered: “I just wanted to tell you those things.”

Finally, I asked each participant at the end of their interview whether they could identify a common theme across the different chapters they discussed. Although the first paragraph of Elliot’s response does not appear to be particularly coherent in the transcription, it is what he said in the interview and he returns to the theme he expresses later.

Sebastian: I have one last thing. You’ve touched on this in some ways, but I’ll ask it anyway. Looking back over all these chapters that you’ve just

talked about, is there a common message, a common theme or a central idea that runs through all of them that stands out to you?

Elliot: Is there a common theme? If there was a common theme, I would say that my experience is that learning has been driven by my environment at least as much as my situation [in life] is a consequence of my learning, if you see what I mean.

You're talking 'chicken and egg'. What comes first? Am I here because of what I've learnt or have I learnt most of what I've learnt through being here?

Thinking back to my ZX81, that was a change in my environment that caused me to learn something. Failing at [the red brick university] was a change in my environment which set me on another path. As I was describing learning during your career, it's changing your environment which triggers learning, in my opinion.

It may well be different for other people, but I think you need to be a very motivated person to really sit down in your spare time and not watch 'Game of Thrones' but actually learn the latest computing technology to a useful standard.

I mean, any fool can look at a YouTube video for an hour or two, but to really learn something to a useful standard and carry through some pet project at home of sufficient complexity to make it worthwhile, you've got to be a more motivated person than me. Simply by changing job or by changing my environment, I'm perfectly capable of learning those things.

Sebastian: Yes. It seems like it's working for you. It doesn't make you unhappy or...?

Elliot: No. If you're looking for a plug for the University of Kent, and I'm sure that's not what you're looking for...

Well, as I said, I did have a think about what was the single most influential thing that had led me to be where I am today. My conclusion there was the earliest thing, and that's that ZX81 computer, but if I was to pick something else, I would say going to the University of Kent was the most life-changing experience, just in terms of taking me from a career that really was dull and unrewarding to a career which is something I thoroughly enjoy and is very rewarding.

I wouldn't be where I am today without the University of Kent. It could easily have been some other university, though.

Elliot's trajectory follows a non-traditional path, if not into computing, certainly into university education. As Mishler observes about lives more generally: "Neither the trajectories of our lives nor the stories we construct to understand ourselves and others are smooth, continuous, and progressive. Each is marked by fits and starts, detours, and hiatuses" (Mishler 2006, p.43). Elliot's path into computing begins with early exposure to his ZX81. However, he does not pursue a university degree in computer science initially.

His story also contains one the most explicit examples of a turning point that was not related to the Year in Industry. Receiving a ZX81 at home at the age of 11 or 12 led to Elliot teaching himself BASIC. While Elliot identifies changes in his environment which could be described as a transition (Enz and Talarico

2016) – “failing at [the red brick university] was a change in my environment” – they also set him “on another path”. And his description of attending Kent as “the most life-changing experience” indicates that it was a turning point for him. Learning, for Elliot, then appears to be tied to transition-linked turning points, which, as in the previous chapter, often form a particularly important role in a person’s life story.

The life story of another graduate, Henry Summers, explores the nature of Accountable Disciplinary Knowledge further. We began our conversation talking about the scope of the interview and I indicated that I was not exclusively interested in learning at university, but learning more broadly. We then discussed his early learning experiences and schooling, which he put into separate chapters of his learning life. Henry viewed school experiences as “rigorous” and recalled pressure to perform well in exams as early as age 10 and 11.

He got his first PC in the early 1990s and one of the friends of his family taught him C. Unusually for the time, Henry took computing both at GCSE and A levels. However, he found that these courses “weren’t academically challenging for someone who is into computing”. We then talked about the university chapter where the very first thing he says is that he did not like it very much.

Henry: I guess the key thing here is learning that I didn’t like academia. I spent a lot of time at university not really working on university work. (Laughter) I spent a lot of time drinking, and socialising, and not doing much.

I nearly left as well. At the end of the second year I thought about dropping out, because I just wasn’t getting anything out of it. I think an

over-riding sense of disappointment as well because I had been so interested in computing, and then to go to university and think, “I don’t like it.”

In terms of dropping out - it was dropping out to just go and get a job as a programmer, rather than continuing with the course, which I didn’t think was benefiting me much.

(omitted discussion of being surrounded by other students at university)

Henry: I felt like it [the academic course side] wasn’t relevant to what I wanted to learn. It’s kind of the typical criticism of academia. It’s in its own little world of stuff that’s not particularly relevant to real world computing. I got that sense when I was at university.

(omitted aside about influence of prior experience)

Henry: I wonder what it would be like if I went back now, as well, in some ways, because a big part of it is who I was at that point. It’s not just about the University itself. It’s the first time moving away from home, and having that freedom, and then trying to work out what I wanted to do with my life. University was, in a sense, almost in the background of that.

I do remember a few run-ins with – well, not serious run-ins. Actually, there was one serious run-in, when I almost got kicked out as well, for not trying in the exams. My marks were quite split. In my second year I got just enough to scrape through, like 47%, something like that.

Sebastian: Okay.

Henry: In the third year, where I actually bothered, I got 70%, something like that. It was split there. (Laughter)

Sebastian: That's quite a jump. (Laughter)

Henry: Yes. That's basically the difference between finding some subjects that I was interested in, and trying quite hard, probably being a bit more settled personally as well, and just not trying at all in the second year, not connecting with it at all in the second year.

It becomes cumulative in a way, because when you don't connect with something you stop going to the lectures. Then when you try and pick it up later you just have no idea what's going on, so it makes it even harder to get back into.

Sebastian: Yes, I think that's fair.

Was it different kinds of learning that made it more or less interesting? Or was it different topics that made it more or less...? For example, I know that we had more project-based stuff later on probably in the third year. Now, I don't know if that was the case when you were there.

Henry: I think it was the same thing. I remember having a discussion with [Anthony Stevenson] at some point, where I was talking about just preferring the project-based work. I remember he said to me there was some university he knew about, somewhere in Sweden I think it was,

somewhere in one of the Scandinavian countries, where the entire course is project based.

I thought that would be so much better for me personally, because that's the kind of thing I like. What I didn't like was sitting in a lecture where they're just telling you a lot of rules that you have to learn again, and you don't really understand why or what it was going to improve.

Probably one of the worst topics for me was – I can't remember what the course was called, but it was formal logic. It was things like Z notation and using Z notation as a formal specification language. I was thinking, "Well, why? I'm never going to do this. And it's difficult. Where's the motivator for me?"

It varies a lot by person as well. Someone like [Thomas Nolan] made functional programming very interesting. I'm probably more interested in functional programming as a result of that, because of him making it interesting.

I did a graphics course in the final year because I knew the lecturer and liked his lecturing style, and he went on sabbatical just before the course started.

Sebastian: Oh, no. (Laughter)

Henry: So it was picked up by – is [Alexander Howe] still there?

Sebastian: I don't think so. I haven't heard that name.

Henry: I think he's probably gone by now. He was quite old when I was there. He had no interest in the topic, and he would just put the microfiche on and read it in a monotone voice. That just kills any interest in a topic.

Sebastian: Yes.

Henry: I think a lot of people at university are there because university wants to attract research money, and they are people who are good at doing research. It's not necessarily the same thing as being good at teaching.

Henry's experience at the University resembles that of the other participants in this chapter in a number of ways. When Henry "spent a lot of time drinking, and socialising, and not doing much", this echoes Elliot Wheeler's experience studying Physics at the red brick university. His description of the cumulative effect "when you don't connect with something" and do not attend lectures reminds us of George Collins experience in his first year at the University. Henry similarly considered dropping out, but, unlike George, continued with his degree. His expression that he would have instead gotten a job as a programmer is reminiscent of Jacob Richardson's description ("I absolutely hated the place and I was seriously considering just packing in and finding a job") at the beginning of this chapter.

Henry also ties his experience at the University to the wider context of leaving home for the first time. He initially explores his newly found freedom upon moving to university. However, in the third year, when he was "a bit more settled personally as well", his grades improved dramatically after he found "some subjects I was interested in".

Throughout the interview, Henry takes a critical view of academia and its relevance to what he calls “real world computing”. This echoes Elliot’s initial stance that most of what he learned at university was actually “irrelevant”, though Henry’s perspective seems to be particularly shaped by negative experiences. For instance, when he takes a course on logic, he cannot see why he should learn about Z notation and, at times, does not attend lectures. However, Henry also has a number of positive experiences. He recognises that certain teaching styles work particularly well for him and says that he is “probably more interested in functional programming as a result of” of Thomas Nolan’s engaging style. Henry also specifically seeks out a graphics course in his final year because of the style of teaching. However, in what is typical of a contamination sequence, this course ends up being taught by somebody who is much less engaging.

Sebastian: You said that university wasn’t really giving you what you were looking for, or that the experience didn’t quite give you that. I guess I’m curious, do you recall what you were looking for at the time? I understand as a 17 or 18 year old you’re just in the middle of it in some ways.

(Laughter)

Henry: Yes, but I think at that time you had Microsoft were a big force. I wasn’t interested in Microsoft per se, but the story about how they got started in someone’s garage in the States, and people turning out of university and just writing code. Java had just come out, and Sun in general were quite an exciting idea of a company.

There seemed to be all this movement in the computing world that was happening very quickly. It was mostly coming out of the States, but not exclusively, and it was basically driven by people writing code. (Laughter)

Sebastian: Right.

Henry: When I went to university it was very much about we would write some code, but there didn't seem to be any point to the code we were writing.

I think I wanted to learn to be better at programming and about using computers. Instead I was learning things which seemed esoteric at the time, and very formally driven, perhaps too formally driven, and didn't really relate to things that I thought I would be doing when I left university.

Henry places what he was looking for from university in the context of the success of software companies at the time. He entered university just as the dot-com bubble was beginning to take off, and his experiences and perceptions prior to applying to study computer science influenced his time at university. But it also exposes the gap between what Henry expected to be learning and what was considered to be appropriate disciplinary knowledge for the first year curriculum by the Computing Laboratory (cf. Ulriksen, Holmegaard and Madsen 2013).

After graduation, Henry worked for a number of companies as a systems administrator, including a law firm. When he found his work not sufficiently intellectually stimulating, he returned to complete a part-time MA in Philosophy at a London university and ultimately switched into a full-time software development position. He called this chapter "Philosophical Itches".

Henry: It was two years for a conversion MA, I think it was, and it ended up with some exams. That was kind of accepting that I wanted to keep learning, that I missed learning.

Sebastian: Right.

Henry: Even though I had this experience before of not being particularly motivated by school, and definitely not getting on with university the first time around, I still thought, “I have a yearning for learning.” (Laughter) Learning I guess in a more structured way than just reading stuff.

Sebastian: Yes.

Henry: Trying to learn things more deeply. It was also rediscovering that I don’t like academia. (Laughter) This was about seven years after I graduated, maybe six years after I graduated. When I went back I still thought, “Academia is just obsessed with academia. It’s not...”

With philosophy you’re never going to be relating to the real world anyway, but the things that I quite liked learning in philosophy is that you read something, you find an interesting idea, and you would follow it.

Then, when you go to university, it’s very much again a formal learning, a prescriptive way of saying, “This is the angle on this topic that we’re interested in learning, and that’s the thing.” You think, “Well, I don’t really care.” (Laughter)

This is a return to themes we previously saw in Henry's life story. When work does not provide the learning opportunities he seeks, he goes back to university as he is still interested in learning "in a more structured way" and "more deeply". However, once again, he finds the academic environment unsatisfying. His expression "Well, I don't really care." exposes his frustration with the gap between his expectations and what the University and its lecturers say he needs to know – that is, ADK – again.

He called the last chapter in his learning life "Learning to Love Programming Again". Throughout this part of the interview, he returns twice to a point I had made earlier in our conversation when I was interested in whether he felt prepared for the changing nature of the computing discipline. I had expressed the view that I did not think it was possible to prepare students for technologies that emerge decades after their university education. (Although I certainly believe it is possible to prepare students to *respond* to new technologies and to teach themselves about them.)

Henry: This [chapter] is a little like rediscovering a love of computer science. You asked a couple of minutes ago about whether the stuff I learnt at university has any relevance to the professional world, and you were saying sort of 10 or 20 years on it wouldn't. I've actually found the opposite.

About 10 years ago I switched from being this kind of sysadmin, or mixed sysadmin and systems programming, to just doing development. I had the opportunity to do development full-time and I took it. I thought it was probably more interesting.

For the last 10 years I've been pretty much full-time a developer, and the last 6 or 7 years of that I've been doing freelance stuff, contract stuff, so I've been going to different companies.

During that time, I've rediscovered a love of programming, which had maybe been beaten out of me by working in a law firm and doing stuff that wasn't that interesting in itself. More recently I've been spending a lot of time going back to the fundamentals of programming, and computation type theory, the real core programming stuff.

Another theme in this chapter is using teaching as learning. As I've become more experienced I've started doing these conference talks at industry conferences. I've done some training materials as well, some training videos for people learning to program. I've been using that as a mechanism to force myself to learn particular things really deeply, because I need to understand them better than my sketchy understanding of them when I go to teach them.

Sebastian: Yes.

Henry: This was going back to stuff that I remember doing at university, and maybe not connecting with first time round, and then suddenly connecting with it now that I'm older, or that I have more experience, or a different outlook.

(omitted discussion of learning through teaching, role of academia)

I think I might be quite extreme along the spectrum, but there are quite a lot of people who are rediscovering things. There was a comment you

made about things that you learnt 10/20 years ago not necessarily being relevant today. One of the things about programming in particular I think is that there's basically nothing new. No, that's not true. The majority of things which are billed as being new today are rediscoveries of ideas from probably the '70s, maybe the '80s.

People are going, "*We invented this great new language*", and you think, "*Well, you've just found functional programming. Well done. That's great. It's kind of simplistic.*" (Laughter) Or a big thing recently was the language called Go coming out. That was in the last few years, and everyone was very excited about the concurrency model in that. You're thinking, "*Well, that's just CSP. That's Tony Hoare in the '70s. That's not cutting edge.*"

(Laughter) I think there's a huge body of knowledge there, that's mature enough now and could be very useful to the real world, but it's kind of locked away and hard to get at.

The beginning of this section argued that ADK is exposed through the tension it creates. Henry's experience is an example of this, as his first year at university was a particularly disappointing experience. Here, the School of Computing and its staff determine what students need to know to graduate with a degree in computing, even as the material is sometimes not what the students expect. The topics Henry and Elliot question centre on electronics, logic, and mathematics requirements, particularly when it was not always clear to them why they had been assigned the work they were doing.

Both of these interviewees relate feelings of frustration that academics are used to hearing from students. Elliot is explicit: "a surprising amount of what you learn ... at university ... is actually irrelevant"; "most people will use none of that stuff". And Henry's experience of relevance is similar "I felt like it wasn't

relevant to what I wanted to learn ... not particularly relevant to real-world computing”; “there didn’t seem to be any point to the code we were writing”. He also talks about being unable to find personal relevance in specific course content “I was thinking, ‘Well, why? I’m never going to do this. And it’s difficult. Where’s the motivator for me?’” He wishes he could have learned in a more hands-on way “I remember he said to me there was some university ... where the entire course is project based. I thought that would be so much better”. These are straightforward expressions of Accountable Disciplinary Knowledge: the only rationale for students being asked to learn these things is because the curriculum (and the faculty who have designed it and teach it) claim that it is important for students to learn these things. Students cannot graduate, and so, implicitly, cannot be computer scientists, without knowing the material they teach. In this, faculty hold students accountable to a view of disciplinary practice that the students themselves do not share. Elliot, Henry, and their compatriots, are being held accountable to someone else’s construction of the discipline.

Nor is ADK localised to educational environments. Elliot finds himself repeatedly held accountable to new disciplinary knowledge when he changes jobs, which he has done with some frequency: “I’m on my third job since leaving that first company, so the fourth job after university”. He does not resent this accountability, however, in the same way as he did with academic learning, but situates it as a simple expectation of employers “It’s: ‘Here is our software project. I’d like you to start working on that.’” Elliot accepts the learning that is required, and even though it is someone else’s determination of what is needed, he does not stand back from acquiring the knowledge, but involves himself with it “... you need to figure it out for yourself ... you just have to engage yourself with the project and the skills that you need.”

However, for Elliot and Henry, ADK has become more than an aspect of their external environment (although it is also that). For each of them, it is a *personal construct*. At the same time as Elliot is talking about his working life, he reflects on how his university education has mediated his subsequent learning, his hard-acquired “real-world” knowledge: “Having studied that at university, I think I am wiser and richer”. This is not a vague generality for him, but located in specific disciplinary understanding “... now that parallel programming is becoming more mainstream” and “more of an insight through having studied the low-level mechanics of how a computer works.”

Henry, too, constructs the understanding of his work, his disciplinary knowledge, in the light of material he was exposed to at university: “The majority of things which are billed as being new today are rediscoveries of ideas from probably the ‘70s, maybe the ‘80s.” And for him, too, this is not a simple umbrella observation but something anchored in particular disciplinary knowledge. When people say *we invented this great new language*, he thinks “Well, you’ve just found functional programming. Well done.” and when *everyone was very excited about the concurrency model* he thinks “Well, that’s just CSP. That’s Tony Hoare in the ‘70s. That’s not cutting edge.”

A different view of ADK comes from another graduate, David Bruce. David’s account was not examined in detail in this chapter (as Mishler may have done) but his view merits inclusion here as it provides a stark contrast:

Yes, I try not to be closed off as well. Again, this is a really difficult thing to get right, because I don’t try to jump from technology to technology, because everything is moving so quickly. I could have

gone, *'Oh, I've got to learn Angular.'*¹⁷ *Angular is really big. Oh, now Ember. Oh, now React.'* You can't keep up with them all and you can't try them all, and you don't have to. ...

But I do worry about becoming a dinosaur. Like if I'm saying, *'Well, no we can do this using a request and response model,'* and everyone's like, *'No, we can do it in Node and have a React front-end,'* I'm like, *'But you're just displaying some information from a database, and now you've had to send someone a megabyte of JavaScript with a library, and hope that they've got JavaScript and nothing's going to munge it. Why wouldn't you just present that on a page from a server, as it's just coming out of a database anyway?'*

I think that sounds like a really reasonable, good point, but other people might be looking at me, going, *'He's a dinosaur. We're doing this rich client thing now. This is the way of the future.'* I don't know if I'm a dinosaur, or I'm a responsible individual. I think the web still has legs, but maybe I'm wrong. Maybe I'm just not reading the tea leaves.
(David Bruce)

David is expressing the hope that his knowledge – and the (in his view, simpler) approaches he is familiar with – remain appropriate given the continued technological developments of the wider discipline. For him, too, ADK is a personal construct, which is expressed here in the tension between the practices and techniques he advocates and these technological developments.

These examples from Elliot, Henry, and David reveal a construction of Accountable Disciplinary Knowledge, of what it means to be a graduate and to

¹⁷ Angular, Ember, and React are different JavaScript front-end frameworks.

work in computer science, that has evolved with their experiences. This is different from the perspective taken by Stevens et al. For them, ADK is exclusively located in the external (academic) environment and largely remains limited to students' time at university (Stevens et al. 2008).

However, as we have seen in this chapter, for Elliot and Henry, ideas with no “relevance” that were initially seen as something just put there by lecturers as a hurdle to graduation have become part of their own disciplinary construction and a knowledge base that they hold themselves accountable to. While Elliot switches jobs, Henry has taken to teaching others as a way of holding himself accountable to the discipline – as he puts it, “to force myself to learn particularly deeply” – and to continue learning outside the academic environment.

ADK is also related to the concept of autobiographic authority explored in the previous chapter as students who take a Year in Industry experience an employer's construction of ADK when they work in a company. For them, though, it is a temporary arrangement and the students know they will return to university to complete the final year of their studies. As they do, they see the curriculum at university with fresh eyes in the light of their experience in industry.

Recall, for instance, how one student's experience during his Year in Industry affected his choice of courses upon his return:

I almost certainly chose different courses because of the year [in industry]. ... I realised, “Oh, okay, crap. I don't like databases, but they're not going anywhere, so I should really understand them.” (Nicholas Bradley)

This change aligns his own view with that of the curriculum offered at the University. Databases, for Nicholas, are no longer simply disciplinary knowledge that he is “accountable” to, but form part of his personal understanding of what it means to be a graduate in computing.

Another aspect of ADK as a personal construct is that it is not easily transferrable. Rather, it is a form of experiential knowledge: different people may, of course, hold similar views on what the important aspects of the discipline are, but these constructions are grounded in their experiences. Autobiographic authority is then one way in which this experiential construction is exposed.

Nicholas’ decision to take a course on databases is grounded in his experience during the Year in Industry. For Elliot, working in industry and being aware of technological developments re-values his learning about parallel programming.

Looking back now, I think that learning about parallel programming is something that’s been heavily added on to the .NET Framework, for example, recently. Having studied that at university, I think I am wiser and richer for having had that studying experience now that parallel programming is becoming more mainstream. (Elliot Wheeler)

Accountable Disciplinary Knowledge then emerges in graduates’ own view, looking back at their experiences, while they are at the same time holding themselves accountable to keeping up to date with the discipline. It is not only constructed in the environment – the particular university or company – it is also a personal construction of the individual graduate that affects and influences their trajectory.

Conclusion

This chapter has presented a uniquely narrative approach to examine graduates' wider learning trajectories. From it, the reader becomes acquainted with Jacob, George, Elliot, and Henry in a way that would not be possible in a traditional qualitative study. This allows the reader to form their own opinions of what the participants say and the legitimacy of the interpretation.

The nuanced expression of ADK presented here would have been hard to identify without this particular approach. As Wackerhausen writes:

“Not everything can be graphed or understood intellectually and detached; something has to be understood experientially. So sometimes objectivity (“truth”) can only be achieved by subjectivity, that is, by an experiential and embodied understanding. ... Narratives can tell me something and make me understand something that cannot be told and understood otherwise.” (Wackerhausen 2009, p.72)

Importantly, Mishler's case-centred approach does not rely on any specific individual but allows for aspects to be compared and contrasted across cases, which is how the multiple expressions of ADK were exposed. These different constructions of ADK (and ADK as a personal construct) are part of an individual's graduateness – of what it means to be a graduate in computing. We now turn to a different group of graduates to examine expressions of graduateness over time.

Study 3: “I told you this last time, right?”

Introduction

The previous two chapters have explored graduates’ learning trajectories through a single life story elicitation, in study 1, *across* several lives and, in study 2, *within* individual lives. In this, methodologically, study 1 adopted a traditional thematic analysis, while study 2 drew on the same data but used a more uncommon case-centred approach. The stories reflect participants’ (learning) experiences and the sense they make of them at the time of the interview. However, this does not afford a sense of how perspectives may change over time. The following chapter turns to a different group of graduates to examine the narratives of their learning experiences longitudinally, across two elicitations, four years apart.

The work in this chapter was inspired by the concept of *rephotography*, a practice of photographers who capture a picture of a place from the same vantage point, sometimes as much as 100 years apart (Brand 1994; Klett 1984). The pictures (also called “doubles”) are then presented side-by-side, or super-imposed, to expose the passage of time. As Paul Berger writes: “By holding one factor constant – the place, person, or event – these doubles direct our attention toward the time that separates them” (Berger 1984, p.46).

This work is similarly interested in changes that occur over time, in students’ wider reflections of their learning trajectories and how they incorporate their experience of higher education within that. While photographs are the medium that exposes changes in the context of rephotography, this work uses narratives. As Mishler observes, “research participants are the historians of their own lives. They tell and retell their stories in variant ways and, thereby, continually revise their identities” (Mishler 2004a, p.101).

Work with college students in the realm of narrative studies has mostly focussed on quantitatively examining the continuity of a variety of themes (such as agency and communion, or redemption and contamination sequences) across repeated elicitations with many participants (Dunlop, Guo and McAdams 2016; McAdams et al. 2006). There are few existing longitudinal studies that rely on narratives and, according to McAdams, in 2011 there were “no long-term efforts to trace continuity and change in narrative identity over decades of adult development” (McAdams 2011, p.108).

There are also few studies in computing education research that have examined students’ identity development (e.g. Kinnunen et al. 2018; Zander et al. 2009), and they generally do not rely on life story approaches. For instance, Peters conducted a phenomenographic study using written reflections with students in two programmes over the course of three years (Peters 2017); McCartney and Sanders used semi-structured interviews in a longitudinal study with American computing students (McCartney and Sanders 2015). Other examples in related fields include longitudinal work by Holmegaard et al. using a narrative methodology to examine how students choose what to study at university and ethnographic work by Stevens et al. to explore students’ experiences in engineering education (Holmegaard, Ulriksen and Madsen 2014; Stevens et al. 2008).

Unlike the previous chapters, which used interviews with graduates from the School of Computing at the University of Kent, this chapter discusses work with a group of a dozen students from a different institution, Olin College of Engineering in the United States. These students were first interviewed as part of a pilot study when they were in the second half of their undergraduate education at Olin (Dzallas and Fincher 2014). Olin is a small undergraduate engineering college with a highly project-based curriculum. The pilot study

identified an “academic dislocation” as students were exposed to different values of what it means to be an engineer at Olin, and began to question the often summative assessment methods they had experienced in high school (Dziallas and Fincher 2014). This provided fruitful ground to return to the participants to examine the evolution of their learning lives. All twelve participants were re-interviewed four years later, after they had graduated.

This chapter consists of two major parts: The first concentrates on the form of the repeated narratives. It identifies the ways in which the stories participants tell about their learning experiences have (or have not) changed. The second focusses on their content, and reports on a thematic analysis to explore graduates’ reflections of their acquisition and use of disciplinary knowledge within and beyond their undergraduate education.

Methodology

Ethical approval was obtained from the Research Ethics Advisory Group of the Faculty of Sciences at the University of Kent and participants were recruited through an email solicitation sent to all students entering the third or fourth year of their education at Olin College of Engineering in 2013. (There was no deliberate selection policy, e.g. to obtain a stratified sample or the like.)

Initial interviews were conducted in the summer of 2013 with twelve students who responded to the solicitation and who were then (with one exception) in the second half of their college education. There were seven women and five men among the participants. Four years later, all twelve participants – who had by then graduated – were re-interviewed using the same prompt. This is an unusually high retention rate for longitudinal work. In the sections below, quotes are identified by the participants’ pseudonym and the year of the interview, 2013 or 2017.

The same narrative protocol was used as in the previous chapters, which asks participants to describe their learning life as if it was a book, and to identify and to describe individual chapters of their experience. In both series of interviews, the prompt was sent to participants in advance, and some used this time to make explicit preparation. The interviewer did not revisit the original interviews before the second intervention (and indicated this to the participants, if asked) in order to avoid being primed to expect specific events, or anticipate sequences, nor be tempted to prompt for them. The first interviews lasted between 10 and 40 minutes, while some of the second interviews were more detailed and lasted between 20 and 60 minutes.

As seen in previous chapters, the life-story chapters elicited using this prompt have “identifiable beginnings and endings” (Thomsen, Steiner and Pillemer 2016, p.143). These, according to Steiner et al., “represent relatively stable autobiographical periods governed by overarching themes and goals” (Steiner, Thomsen and Pillemer 2017, p.479). In titling their chapters, some participants – similar to the Kent graduates in study 1 – simply named locations of their education, such as schools (and, later on, employers), whereas others used more interpretive names, such as “Taking the Red Pill” or “The Mad Dash”. As Thomson et al. note, “Each chapter is associated with information about the people, objects, activities, and locations typical of the period. In addition, chapters are evaluated emotionally and become characterized by positive and negative tones” (Thomsen, Steiner and Pillemer 2016, p.144). (Appendix 3 contains a full table with all chapter titles from these interviews.)

In some cases, interviewees did not explicitly name a chapter. (For the first interviews, I was less experienced and did not always press participants to identify chapter titles.) However, segments can still be identified based on

participants' descriptions, as the beginning and end points of each segment remain clear, even without a title. Where chapters were identified in this way, this is represented in curly brackets in this chapter and in the appendix.

Olin Context

Olin College of Engineering is an undergraduate institution in the United States which was founded in 1997 with an explicit mission to transform engineering education (Kerns, Miller and Kerns 2005). It is a highly selective institution with an acceptance rate of around 10% in recent years and uses a two-step admissions process. In addition to the typical college application that involves essays, grades, and letters of recommendation, applicants are selected to visit campus for a mandatory "Candidates' Weekend". As part of this, they meet current students, faculty, and staff. They participate in a design-build challenge designed by current students and take part in individual and group interviews (Frey, Horton and Somerville 2002). The purpose of Candidates' Weekend is not to evaluate candidates' technical abilities, but to expose them to the campus community and to assess their cultural fit with the institution. Each year, around 200 candidates are invited and approximately 60% are offered admission.

The college has a total undergraduate population of 350 students and, unusually for an engineering school, is equally gender balanced. All students are required to live on campus and to subscribe to an all-inclusive meal plan; they have access to all buildings and classrooms at all times of the day. Olin does not have academic departments and offers no tenure; faculty are instead hired on renewable, five-year contracts.

Olin offers ABET-accredited degrees in electrical and computer engineering, mechanical engineering, and general engineering. For this latter degree, students can design their own concentration or choose from a number of predefined

concentrations, such as computing, design, bioengineering, or robotics. There is significant flexibility surrounding the major declaration: While students are expected to initially declare a major in their sophomore year, they are able to change their degree as late as in their senior year (provided they can fulfil the necessary course requirements).

The curriculum emphasises small, project-based classes and incorporates principles of active learning and interdisciplinary activities (Somerville et al. 2005). Many courses are taught in studio environments, sometimes by several faculty members as part of a teaching team. Olin aims to introduce real-world engineering activities and team-based learning from early in the curriculum.

All incoming students take four courses in their first term, which are designed to provide immediate hands-on engineering experience. In *Modeling and Simulation of the Physical World*, they examine real-world problems by developing mathematical models using MATLAB. *Introduction to Sensors, Instrumentation and Measurement* exposes students to electrical engineering and principles of circuitry as they conduct experiments using sensors in a lab environment. And in *Design Nature*, students learn to use CAD software and build nature-inspired prototypes in the machine shop. In the second half of the course, they work in groups to design toys aimed at fourth graders, which are then tested and evaluated by a group of local fourth graders at the end of the term. The fourth course is a social science foundation in a topic of the student's choosing: offerings include courses on the *History of Technology* and *What Is 'T'*?, among others. The curriculum in the first semester is offered "pass / no record" in order to allow students to adjust to the learning environment. This means that if a student fails a course, this does not appear on their transcript, although they would have to take it again in order to fulfil the requirement.

User-centred design also features prominently in the curriculum: “Our curriculum is based on the idea that engineering starts with people – understanding who we’re designing for, what they value, and where opportunities to create value exist – and ends with people – appreciating the social context of our work and making a positive difference in the world” (Olin College 2017). *User-Oriented Collaborative Design* is a required course that all students take together in their sophomore year. The curriculum ultimately culminates in a year-long capstone project – either a design project with the goal to address poverty in communities around the world, or one offered and sponsored by a company.

On Repeat

“Probably most stories are potentially repeatable but not necessarily repeated.”

(Norrick 1997, p.200)

Participants were interviewed in 2013 and again in 2017. At the outset, one might think that lives – learning lives – largely remain the same: the participants would still have attended the same schools and been taught by the same teachers. However, different types of story emerged in participants’ narratives. The following describes the different types and presents a classification scheme.

Firstly, as expected, some within the cohort told recognisably similar stories on both occasions. These are *stable stories*. Others, however, followed different patterns. A second pattern of *compression stories* emerged. As human beings, as we move through time, more recent events are closer, the details are sharper, and they may take greater prominence. Telling a story, then, “... is about a distortion of time, prolonging a few precious moments, skimming a month at a time, entire years, intimating the ending in the beginning, blithely shifting scenes and times

and sequences in order to further the plot” (Mattingly 1998, p.15). Some in the cohort displayed this type of difference.

A third pattern were *landmark stories*. As time progresses, events that happened a long time ago remain very familiar, and may act as anchors for a particular meaning, or serve a narrative necessity “of course it happened like that”. Some participants had such fixed elements within their twin narratives. More difficult to account are *different stories*: narratives that are so wildly dissimilar that, without external knowledge, one would not know they were from the same person at all.

Finally, the longitudinal methodology in this study also exposed aspects that had gone unmentioned in one interview but not the other. According to Charmaz, “What participants do not say may be as telling as what they do say” (Charmaz 2002, p.304). These elements are *omitted stories*.

The types of story identified here are different from “retold” or “shared” stories as they are commonly examined in the literature, where they are seen as occurring in everyday conversations (e.g. Quasthoff and Becker 2005). Norrick, in his work, explores retellings in three different conversational contexts: an “immediate retelling” in a group as a new person joins the conversation, retellings to different audiences several days apart, and the joint construction of stories within a group (Norrick 1998). For him, twice-told tales are “narrative events built around stories already familiar to the participants” (Norrick 1997, p.199). Yet, he similarly observes that these stories sometimes remain largely the same across tellings, whilst at other times elements are omitted, stories restructured, and endings reinterpreted depending on the audience and the goal of the narrator (Norrick 1998; Norrick 2005a).

Stable Stories

For some participants, the way they narrated their learning life remained recognisably similar across the two interviews. The chapters they identified straightforwardly match the specific schools they attended, with additions for the companies they worked at since graduating. This is particularly apparent in the accounts of Michelle Young, Kathryn Benz, and Peter Webb, where the chapters they identified remained consistent across both interviews.

For instance, the chapters Peter identified in 2013 were “{home schooled}”, “{high school}”, “{[large public research university]}”, and “{Olin}”. In 2017, he named them “Home Alone”, “High School”, “My Year at [large public research university]”, and “Olin”. Kathryn’s sequence is superficially dis-similar as she did not name chapters in her initial interview, and has three additional chapters in 2017. However, her chapters refer to the same periods of time, with the same beginning and ending markers.

For McAdams, “Identity stability is longitudinal consistency in the life story” (McAdams 1985, p.18) and we have seen learning identity stability – as expressed through the chapter titles – in these accounts.

Compression Stories

In the original interviews, participants often spoke about their formative learning experiences and high school careers, but little about their experience at Olin. This may have been the case as high school was still prominent in their learning lives. In 2017, then, one would expect that their undergraduate studies would take that place and that they would recall those years in detail, with less emphasis on prior experience. And for some that was true.

Obviously, I guess the thickest chapter here would be moving to Olin and that experience there. (George Andrews, 2017)

Susana Clinton articulated in 2017 how she remembered little of her earlier learning experiences.

I feel like a lot of my learning career has lumped together now. I feel like I would have defined it based on areas of interest, or school years, before. Now, it's like *before Olin* and *during Olin*, and *after Olin*. ... Man, everything before Olin is kind of a blur all together. (Susana Clinton, 2017)

There were similar themes in the chapter titles of several other participants. For Natalie Lee, her learning experiences at school were originally three individual chapters. Now, she gathers them under a single umbrella called “school learning”. And Jesse Walker, who previously formed four separate chapters, “{elementary school}”, “{fifth and sixth grade}”, “{seventh and eighth grade}”, and “{high school}” subsequently identifies this time with in just a single chapter entitled “Buying In”.

Landmark Stories

For other participants, while the larger structure of their stories evolved, some episodes did not change. This may not seem unusual, but it was surprisingly rare. Across all the interviews, there were only four of these “doubles” and they share similar features: they are often described in the same language; the episodes stand out of the timeline (no matter whether it is expanded or compressed around them) like landmarks; and they have significance to the participant greater than the content of the event would suggest.

Basically it was down to one test, and the way [my state] grades is if you are 89.5 or higher, that is an A. Oh my gosh, I rocked those 89.5s like nobody's business. I just remember that day, that I had a B and I needed to get the A, I literally had an 89.57, and I got my A. (Natalie Lee, 2013)

In [my state] ... an A is an 89.5 and I lived the 89.55, 89.57, 89.6. If you were to look at my grades, most of them were that. It was not a good situation. Trying to get just enough to get by. (Natalie Lee, 2017)

This episode is clearly an important one for Natalie and is stabilised by her using the same language. As Norrick writes: "The virtual identity of certain phrases from one telling to the next suggests significant nearly verbatim recall of whole chunks or a consistent use of specific narrative techniques at crucial points in a story" (Norrick 2000, p.83). But it is not necessarily told in the same way in both accounts. In 2013, she describes this in the context of being offered the chance to take a special calculus class in her senior year if she meets the grade requirements and her claim of "rocking" the A grades sounds very positive: it is an achievement. In 2017, Natalie tags the recollection by saying that "It was not a good situation" and now seems disapproving of her former self.

Another example is in the stories of Evelyn Finn and her dislike of a particular teacher.

The sad part was, the teacher that I didn't like in fourth grade moved up with us to fifth grade. (Evelyn Finn, 2013)

This experience is clearly meaningful for Evelyn in relation to her learning but she says no more about it. In 2017, she relates the same instance:

It was actually really funny in my elementary school, I had a teacher in my fourth-grade year that I didn't really like. We did a lot of quiet work sheets in her class or watching videos and I was just not into it. Then she moved up to fifth grade when I moved up to fifth grade. I was just like, "Oh." (Evelyn Finn, 2017)

There is more nuance and detail in this telling. The teacher's style – relying on "quiet work sheets" – does not seem to work for Evelyn, who is clearly a well-performing and self-motivated student. Indeed, she says that she "felt like I was learning key words a lot. ... I was just like, 'What is this? Why am I doing this?'" She indicates both disappointment in this way of learning, and her resignation to it, with the inclusion of the final "Oh."

George Andrews describes his experience taking a foreign language class at Wellesley College (where Olin students can cross-register) in both interviews. He relates an anecdote and attaches it to a clearly powerful realisation.

... it seemed as if the students who were getting As didn't know [the foreign language] any better than the B students. It's that they had just memorised more words. ... If you focus exclusively on something, you can be the master at it. If all you have to do is spend time on it, then what's the point of letter grades? You're saying an A student is a B student with less to do. ... That was really transformative for me; I really stopped worrying about grades at that point. (George Andrews, 2013)

In 2017, he recalls the same incident, and attaches the same realisation to it:

I was taking [a foreign language class] at Wellesley and I simply didn't have the time to invest in it that some of the other students did (and to

be fair, that the instructor had asked that we put into it as well). As a result, in all of the evaluations I tended to fall short of what I felt I was able to do. Then in class when covering new content and it was simply a measure of, “How are you able to synthesise and respond in the moment?” I seemed to be better off than the students who had got 100 on their quizzes ... the sense of numeric measurement really lost its gold standard. (George Andrews, 2017)

Finally, another participant, Samuel Cline, talks extensively in his first interview about a planetary space exploration programme he attended while he was in high school.

... the biggest moment ... was a [planetary space exploration programme] I participated in ... doing some real (to the extent young high school students could do) real scientific experiments that actually had worth.

I was doing actual experiments and they weren't just things [like] little experiments with M&Ms or something, that anyone who knew anything about the basic concepts knew exactly what the experiment was going to do at the end. (Samuel Cline, 2013)

This is clearly a significant experience for Samuel, as he describes it as the “biggest moment” and, later, as “a pretty big transition in the way that I viewed my own learning”. In 2017, Samuel talks less extensively about the program, but the force it had for him remains clear:

It was one of the first times in a science class that going into a lab I couldn't guess the outcome before it, because it was actually doing something that I didn't know the answer to. Not, “Here's a boxed lab

that we went over the material last week, and now you're getting to see it," (Samuel Cline, 2017)

A common element in the two tellings of his learning life remains his exposure to authentic scientific practice and the powerful effect it had on him.

These stories emphasise different elements of landmark stories: Natalie uses strikingly similar words across both interviews; Evelyn provides little context, but the episode stands out from the rest of the narrative; and for George and Samuel, their story relates to an important insight for them. These stories were not more vivid than those others told, but the episodes act as anchors for meaning that is persistent across interviews. This is not something that would have been evident in a single elicitation – the strength of the meaning is only revealed through repetition.

Different Stories

The accounts of some participants had so few points of similarity that, if presented without identification, it would be hard to say they were stories of the same person. And it is not only in the overall structure of the account that there is divergence, but in the individual incidents also. For example, in 2013, Jesse Walker describes his transition from school to college in this way:

In high school we had a very traditional learning environment. The teachers were all old and wise but they helped me out. They gave me some advice, told me Olin might be a good place since I didn't seem to like the traditional stuff. Then I got into Olin. I don't know how. (Jesse Walker, 2013)

In this account, there is a feature which is part of a common theme across almost all the interviews: school is a “traditional learning environment” and Olin is not. Aside from that, the rest of the incident is personal. Olin is suggested because his teachers know he does not like “traditional” learning, they are “old and wise”, and from this formulation we adduce “kindly”; there is no sense of malice, no sense that these teachers are not acting in his interests. Actually getting into Olin seems to be a process of almost magical transfer “I don’t know how”.

In 2017, the same incident is recounted differently.

I was advised that because I’m talented, or because I got good grades in the maths and sciences, that engineering school is a good place. Also, that seeking the best ranked school that I could possibly fit into is, obviously, what I want to be doing because I want to be maximising my earning potential, my learning potential. So, I was like, okay, cool, I’ll do that.

I knew [Olin] was going to be a little bit unexpected and a bit like veering from some sort of upward and outward path. But, at the same time, it was the best ranked engineering school I got into. Which is exactly what I was aiming for. (Jesse Walker, 2017)

Here, the quality of the advice is different. His advisers now are impersonal and they treat him impersonally. Their generic advice is proffered on the basis of “good grades in the maths and sciences” and that “obviously” the purpose of going to college is to get a job that will make a lot of money. From these axioms it follows that engineering is a good subject choice and a high-ranked university desirable: the same advice could apply to anyone. And maybe it wasn’t appropriate to Jesse. This time, the process of getting into Olin is a very

deliberate act. Olin was the highest-ranked university (of the high-rank universities that he applied to) that accepted him: “which is exactly what I was aiming for”.

The prompt used in this work encourages not only a narrative recounting (i.e. a sequenced, often chronological, report) but also a storied one. Asking participants to recount their learning life “as if it were a book” makes available certain constructs, such as plot and narrator. Even though stories were elicited from the protagonist, they are in a privileged position as narrators, and that privilege comes from knowledge: a narrator knows the ending. As Mattingly observes, a narrator “is able to select the relevant events and reveal their causal relations because he knows how events unfolded to bring about the particular ending which, narratively speaking, gives meaning to those events. ... The story’s structure exists because the narrator knows where to start, knows what to include and exclude, knows how to weight and evaluate and connect the events he recounts, all because he knows where he will stop” (Mattingly 1998, p.38). In contrast to fictional stories, the ending in a life story is usually the present time. And the narrators – the interviewees – make sense of their experience from their present point of view.

It would be easy to cast Jesse’s 2013 and 2017 accounts as simply inconsistent. But between the two tellings of this story, the ending has changed. The student has graduated: Olin is now an episode, not lived experience. Jesse is now in employment and looking to an unknown future. In re-telling his story, the new ending has changed both the interpretation of and the accounting of this transition; an inconsistent account does not imply an incoherent account.

Omitted Stories

For all participants there were elements that appeared in only one narrative. Omissions took various forms. Some were very personal details (illness, family deaths or thoughts of suicide); others were vivid, apparently important, scenes of learning that we heard only once.

One participant, for instance, described “the real point in my life was that I was suicidal, which was one reason I didn’t really have much ambition” in the re-interview.¹⁸ We also learn that their “relationship with my family was falling apart all throughout Olin. ... So I don’t really talk to my family anymore.” These are not instances that were mentioned in the original interview in 2013, perhaps as this participant was in the midst of the experience. However, in 2017, the participant acknowledges that they are relevant to the story, “I’d better just say a side-note.”

Another example is the account of Kathryn Benz, who, in 2013, does not mention computer science or programming at all. However, in the re-interview, she talks repeatedly about computer science, and describes several early experiences of computing at school. This sort of omission may be a result of the changed viewpoint of the narrator. At the time of the first interview Kathryn may not have been considering a career in computing; however, by 2017 she had entered a computer science PhD programme. Given this new situation, previously unreported details of her past have become salient.

¹⁸ Where sensitive events are discussed in this section and where attribution to a specific participant would make them identifiable, the names of participants have been omitted to protect their identity.

A number of researchers have examined *which* stories participants choose to tell using the concepts of *tellability* and *reportability*, often in a conversational context (Labov 1972; Sacks 1992). For Labov, tellability is tied to the contents of the narrative: It is about “why this narrative – or any narrative – is felt to be tellable” (Labov 1972, p.370). For Sacks, reportability is similarly related to whether an event is newsworthy itself (Sacks 1992). Kathryn’s experience studying computing may simply not have seemed newsworthy to her in the first interview.

However, as Shuman observes and as we have seen above, certain events – such as death and suicide – may be “tellable” according to these definitions, yet also remain “the most untellable” due to their traumatising nature (Shuman 2011, p.129). Norrick calls this the “dark side of tellability” (Norrick 2005b). He writes: “Some events bear too little significance (for this teller, this setting, these listeners) to reach the lower-bounding threshold of tellability, while others are so intimate (so frightening) that they lie outside the range of the tellable in the current context” (Norrick 2005b, p.327). Norrick’s definition of tellability focusses on the narrator, but there are also certain stories that are untellable for a different reason, because they are suppressed by society. Stories of sexuality are one such example. Plummer, in the context of “coming out” stories, observes that these stories are unsayable when there is no community to recognise them: “Stories can be told when they can be heard” (Plummer 1995, p.120). A more recent example of this is the *#metoo* movement as part of which accounts of sexual assault have become accepted in the discourse in media, culture, and society.

A different form of omission is what psychologists call *door knob revelations*. These are statements made at the end of a session – in this case of an interview –

that are significant to the participants' experience but are not acknowledged until the very end.

I think the thing outside of what we talked about that I didn't mention; my dad died a little over a year ago so my perspective might have shifted some. I think for a while I was focused on finding the learning. Then after that I was a little more focused on just getting by for some time.
(2017)

In this specific example, the participant had already indicated that they did not have anything else they wanted to discuss as part of the interview. Here, however, as the last thing before we conclude the interview, they acknowledge that their perspective "might have shifted" as a result.

Silences were also sometimes perplexing, when aspects that seemed so clearly important – and were vividly recounted in the original interview – were not the same across interviews or not mentioned at all. Take, for example, this description from the interview with Leon Clay:

One of my earliest memories is this toy that I had that was a balance-beam thing. It was a lever, the fulcrum was in the middle, it had pegs numbered going out and there were little weights that were also numbered according to their weight. I remember coming to this huge revelation that if I put two weights on the '1' peg and one weight on the '2' peg, then it would balance. Then, when I was learning multiplication, it all made sense to me because I'd had that. When I was learning torques, it all made sense to me because I'd had that. (Leon Clay, 2013)

This seems to be a central and important feature of Leon's learning life, not only as an initial revelation, but in its subsequent importance when learning other material. One might expect to hear this story – or its impact on subsequent learning – again, in the re-interview. Yet, there was no trace of it. In contrast, consider Evelyn Finn's description of the teacher she did not like, which was discussed as a landmark story above.

The sad part was, the teacher that I didn't like in fourth grade moved up with us to fifth grade. (Evelyn Finn, 2013)

Here, there is very little detail of the actual event – it certainly does not have the same vividness as Leon's story. Yet, we know it is important, because we hear it in both interviews.

These omitted stories are exposed through the use of a longitudinal methodology in this chapter, as it becomes apparent what was “missing” in one of the narratives. Yet, these silences are not intended to deceive. For example, when in 2017 a participant freshly revealed “I'd heard about Olin through my brother ... my brother was recruited by Olin and didn't end up going” they tagged it with “I told you this last time, right?”

Omitted (and different) stories present particular challenges to researchers who employ narrative and qualitative methods. They interpret and assign meaning to the stories participants tell (Plummer 2001). It may then appear as if an interpretation is not valid anymore – or, worse, may have been “wrong” all along. As Leon's omitted balance beam story shows, just because an element of a story strikes us, as researchers, as particularly vivid does not mean that it is necessarily central to a participant's learning life. This is an example of a researcher's “false friend”.

This raises questions about what constitutes a valid interpretation of a life story, particularly if two elicitations do not result in the same telling. Of course, one would expect two elicitations of a participant's life story within a short period of time to result in similar stories. Mishler encourages researchers in his book *Storylines* to conduct at least two interviews with each participant (Mishler 2004b).

There are many reasons why an element may be mentioned in one interview but not the other: perhaps the narrator thinks that they have mentioned an episode before and assumes familiarity with the topic; perhaps time has passed and their perspective has changed so that they do not recognize the episode as important anymore; perhaps they choose to tell a different story to a different interviewer altogether (though in this study the same interviewer conducted both interviews); perhaps they have forgotten, or even misremember the event themselves.

Some researchers have also raised concerns over whether the stories elicited through narrative methods “truly reflect” events as they occurred. Empirical work has provided evidence that stories are prone to revision and that experiences, memories, and the sense people make of them shape their identity – and vice versa: “Who we are may be shaped by our memories, but our memories are shaped by who we are and what we have been led to believe” (Loftus 2003, p.872). This is reflected in an observation by the journalist David Carr, who writes: “Memories may be based on what happened to begin with, but they are reconstituted each time they are recalled—with the most-remembered events frequently the least accurate. What one is remembering is the memory, not the event. And memory uses the building blocks of fiction—physical detail, arc, character, and consequence—to help us explain ourselves to ourselves and to

others” (Carr 2008, p.334). This feeling of unreliability was also observed by an Olin graduate who said:

Just because I have reflected on it so much that even those stories, I think, are a little tainted. (Jesse Walker, 2017)

However, as person’s (learning) life story is constantly under revision, it is this construction that is of particular interest to researchers. As Rosenwald and Ochberg write: “the object of study is not the “true” event, as it might have been recorded by some panel of disinterested observers, but the construction of that event within a personal and social history” (Rosenwald and Ochberg 1992, p.3). Indeed, this work is not interested in whether the stories told reflect an objective truth, but in how they are told and what they reveal about the person telling them (Gubrium and Holstein 1998).

Common Themes

“Predominantly, narratives of personal experience focus on past events, i.e. they are about “what happened”. However, such narratives link the past to the present and future life worlds ... The telling of past events is intricately linked to tellers’ and listeners’ concerns about their present and their future lives.” (Ochs and Capps 1996, p.24)

For all participants in this work, the space between the interviews was one of personal change: at minimum out of undergraduate education and for some of them much more, starting jobs or changing countries. The following turns from the form of participants’ stories to their content and reports the results of a thematic analysis (Braun and Clarke 2006). Three themes emerged in the interviews as participants entered the workplace: students’ acquisition of

disciplinary knowledge, the re-positioning of their Olin education, and stories of continued learning beyond university education.

Acquisition and Use of Disciplinary Knowledge

The computing curriculum at Olin is deliberately small (Downey and Stein 2006). This is in part due to pressures that are similar to those at liberal arts institutions – a small number of computing faculty and a larger number of general requirements than at technical institutes (Downey and Stein 2006). A concentration in computing at Olin requires students to take *Software Design* (an introductory programming course using Python), *Discrete Math*, *Foundations of Computer Science* (a higher-level course that combines aspects from traditional algorithms, programming languages, and compilers courses), and *Software Systems* (which draws on materials on operating systems and networks, among other topics). This is complemented by at least two other elective courses of the student's choosing.

Coming to know CS

Participants came to computing in different ways.¹⁹ Their origin stories (that is, the backstory of their exposure to computing) show well-known influences for taking a technical degree, such as knowing someone who is associated with computing. This matches other researchers' findings: In engineering education, the *Academic Pathways Study* showed that several motivational factors influence students' decision to pursue a technical degree, including mentor and parental influences (Atman et al. 2010). Ching and Vigdor identify these "catalyst people" and, in their study, found them only out-of-school, not in teachers or formal

¹⁹ This section only includes the six people interviewed who were computing students or subsequently pursued a career in computing.

advisors (Ching and Vigdor 2005). The data in this study confirmed this: this sort of engagement was not found in the educational environment.

I was raised by an electrical engineer who was very hands-on. He was one of the first computer engineers, so he very much believed in getting your hands dirty. (Leon Clay, 2013)

Yes, so when I was in fifth grade, we had a family friend who went to [a local university], and she studied computer engineering. At that age, she was my favourite person, she got me a shirt [from the local university], I was super excited! So, in our yearbook I wrote, “When I grow up I want to be a computer engineer.” And I had no idea what that meant. (Irene Luna, 2017)

It may be that this prevalence of personal contact as a motivator to study computing is generational. As computing becomes a more common subject in schools, students may find their way to the subject through charismatic and engaging teachers, as already happens in other disciplinary contexts.

... we had a really fantastic maths teacher named [name], who I had for Tenth Grade and Twelfth Grade. He was actually a British rocket scientist who couldn't get a job because of clearance issues. You can't work for NASA. So, he ended up teaching high school maths and he tied it into physics, and all of us wanted us to be engineers – everyone in his class. (Kathryn Benz, 2017)

Kathryn had mixed experiences early on, particularly in computing classes at school, and found her way back into computing when another Olin student became a mentor for her.

How I learn to like CS, I think was a very interesting path, ... not really liking it in Ninth Grade ... and not really liking it, Tenth Grade or Twelfth Grade. Then, coming to Olin and not really wanting to be a computer scientist. Thinking I was going to be a mechanical engineer. It was really [another Olin student] dragging me to hackathons and then starting to do projects with me. He'd be like, "Do you want to be on my team?" That got me into computer science. (Kathryn Benz, 2017)

In terms of student attitudes and pathways into computing, a number of researchers have examined how the computing experiences a student has prior to applying to study computer science influence their time at university. Schulte and Knobelsdorf explore the influence of *biographical effects* on students' attitudes towards computing (Schulte and Knobelsdorf 2007). They note that prior experiences, such as programming courses in high school, may serve as a starting point or as a barrier for students, as we have seen in Kathryn's story.

These goals and attitudes are sometimes grounded in long-held beliefs and early (if erroneous) conceptions of the discipline.

I have known that I have wanted to be an engineer since I was seven-years-old.... (Leon Clay, 2013)

I had always thought that I would prefer computer science to computer engineering, because of some messed up preconceptions about what each of those things meant. (Irene Luna, 2017)

Hewner and Guzdial also identify pivotal experiences in students' autobiographies (such as a teacher encouraging a student to pursue a career in

computing) (Hewner and Guzdial 2008), and Ko highlights the role technologies, such as video games and programmable graphing calculators, play in students' early encounters with computers (Ko 2009).

I was on the computer a lot, because I like watching movies online. So somehow, my family got this idea that I was good with computers. So it was like, "Hey, you should be a computer engineer." I was like, "Okay, I can do that." (Peter Webb, 2017)

In the Classroom

Some, although not all, of the participants learned computing in the classroom. However, these experiences were not always positive.

I took my first Computer Science class, I actually hated it. I liked it and then I hated it, and then I liked it... There were only four of us in the class and a lot of the time we used to ditch class. (Kathryn Benz, 2017)

Hewner observes that negative experiences in one class can lead to students avoiding large areas of the discipline entirely (Hewner 2014). One example of this was the account of Peter Webb, who attended a different university for a year before coming to Olin. The introductory programming class he took there was taught in Java and did not resonate with him.

Anyway, so fall semester was the first time in my life I ever learned a program. I didn't even know what programming was. I thought it was like ones and zeros. The programming language the class decided to teach was Java. ... It was terrible. I think I got the first C ever in my life. ... I actually decided I didn't want to go into programming. (Peter Webb, 2017)

However, at Olin, Peter took the Software Design course (taught in Python) and decided to audit a website-design course at Babson College (another school where Olin students can cross-register).

Yes, Software Design. So I took that, and I got reintroduced to programming, and it was like, “Hey, it’s not as bad as I thought it was.”
(Peter Webb, 2017)

Outside the Classroom

Other participants did not consider that computing was learned through the formal curriculum at all.

[At Olin] ... I did software-y things, but my internships were with the government, instead of being with industry, and they were around, sort of, more machine learning and data science stuff. ... I think most people at Olin who knew software engineering got that stuff more through internships, and my internships weren’t in that space. (Michelle Young, 2017)

And indeed, Michelle’s impression is borne out in the experience of another participant, one of his most important learning experiences came through an internship.

So after my sophomore year, I got my first internship at a company called [Liveworks]. I was answering emails. I was going into people’s websites and figuring out what was wrong, what was going on, what errors were they seeing and stuff. I would not do it again, but it was probably one of

the most valuable experiences I've ever had, because you get to see how exactly people are reacting to your product. (Peter Webb, 2017)

Participants additionally discussed their transition from college to work. Begel and Simon, who explore new software developers' experiences at Microsoft, saw them undergo a transition from novice to expert when they enter university, and again as they start their first job (Begel and Simon 2008). A similar phenomenon emerged in the interviews:

In the same way that going from high school to college was a very fundamental contextual change, going from school to career was also a fundamental contextual change. ... Certainly, the first six months were overwhelming just as a new adult and all of the things that go along with life and moving into a city. (George Andrews, 2017)

In their work, Begel and Simon noted that many of the problems participants experienced were caused by a lack of social and teamwork skills (Begel and Simon 2008). The new software developers also had to negotiate what they feel they can ask their colleagues. Begel and Simon write: "Asking questions, however, reveals to your co-workers and managers that you are not knowledgeable, an exposure that most new developers felt might cause their manager to reevaluate why they were hired in the first place" (Begel and Simon 2008, p.9). This, however, does not appear to be a universal issue, as we see Michelle's retelling.

Like, sometimes, it's a little embarrassing to be like, "So guys, tell me more about what you mean when you say the word 'code review'. What is that word, exactly?" You know, you only have to ask those questions once. There are a lot of context clues around. People are super-willing to

forgive 21-year-olds for not knowing anything. So, it didn't take that long and it wasn't that hard to pick that stuff up. (Michelle Young, 2017)

Re-positioning University Education: "Olin as inevitable"

Looking at both sets of interviews, a shift emerged in how participants positioned their experience at Olin. In the first narratives, Olin is often represented as an achievement, a sort of capstone to their learning life.

Actually, look at that, we start with gifted school, we go to Montessori school, and then we go to public school. Not a good progression, right? It doesn't make any sense. But that is what I did, and that is how it got me to Olin. (Natalie Lee, 2013)

In these interviews, Olin is presented as an institution where traditional aspects of education are not in focus.

I think for the majority of my time in public school, I felt like I was learning in spite of my classes, maybe. Like I learned things for a test and I would take the test; it would be fine and I would forget them. ... But I feel like Olin gets what the right thing to teach is. Like the idea that it's about skills and about developing your ability to adapt. Sort of figuring out how to do things and what to do, not necessarily learning facts. Like the fact that they get that makes the classes really awesome. (Michelle Young, 2013)

In the second narratives, the Olin experience has been re-positioned. It is now subsumed into a single sequence and a theme of "Olin as inevitable", or, rather, as a continuation of previous experience, emerges.

when I think about Olin... when I was reflecting on thoughts about learning, I think that really college was just like... I called it 'Solidification'. ... so I had already thought that there are lots of ways to learn, and these are all valuable. ... [Olin] just did a great job of saying, "Yes, these are all valid [ways]." (Ashley Hayes, 2017)

... I wonder how much Olin had an effect on me, or [whether] these things already were in place. I think we tend to look back on Olin and think that Olin had a huge dramatic impact on us. I do think it did. It's interesting to me that when I think about stories that affect my learning, ... I had already known that's how I want to learn, and Olin just happened to be a case study in that. (Kathryn Benz, 2017)

Here, Ashley and Kathryn similarly reflect on the position of their Olin education in their learning lives, and these reflections may be more than individual. As Olin overtly positions itself as providing a different kind of engineering education, this identification may be a *master narrative* that they have previously adopted as students (McLean and Syed 2015). Indeed, master narratives, as stories of culture, are cultural scripts available to members of a particular group, such as students at a specific institution (Hammack 2008). As Andrews writes: "One of the key functions of master narratives is that they offer people a way of identifying what is assumed to be a normative experience. In this way, such storylines serve as a blueprint for all stories; they become the vehicle through which we comprehend not only the stories of others, but crucially of ourselves as well" (Andrews 2004, p.1).

Kathryn makes this point particularly explicit. Throughout her time at school, she participated in a creative problem-solving team competition, which she identifies as "one of the reasons I wanted to go to Olin."

I already knew that [the creative problem-solving team competition] was how I wanted to learn and how I learned best. Then, Olin happened to be four years of that. So, it provided me with a methodology and a way to do that, but it didn't fundamentally change how I thought about learning. (Kathryn Benz, 2017)

Samuel Cline similarly expresses a sense that he was looking for – and that Olin offered – a different kind of education, perhaps as a result of the planetary space exploration programme he took part in.

And I think it kind of works nicely with the experiences from high school. By the end of high school, I was pretty clear that I wanted something different. ... Olin kind of offered that, in terms of having a very different education style and obviously having a lot of self-directed learning. (Samuel Cline, 2017)

For these graduates, Olin is now a continuation of the ways of learning that they had previously been exposed to. However, it does not diminish the effect of the education. Rather, it exposes a refashioning of what it means to be a graduate. These students are now “products” of Olin, which is an externally visible and tradable attribute, and are incorporating that as they make sense of their continued learning. As Rich writes: “On graduation, the university gives the student a stamp of approval and takes credit for any personal growth or development they may have experienced” (Rich 2015, p.4).

This repositioning may be the result of an evolution in the narrator's stance. As Mattingly says, narratives “are ordered around an ending and it is the ending which has a fundamental role in shaping the meaning of the narrated events”

(Mattingly 1998, p.38). It also provides causal coherence across these stories of participants' learning lives, as they are told now, several years after graduation: now "of course" they ended up at Olin. The participants are then telling their stories in a way that exposes their continuing ways of making sense of their experience.

Beyond University Education: Work Stories

None of the participants talked about their university education as preparation for work; and some of them were quite explicit:

I probably can't point to anything [from Olin] that's like, "Yes, this experience definitely helped me last Wednesday, when I needed to do X, Y, or Z," or helped me get the job I have now, or anything like that.
(Samuel Cline, 2017)

... as much as Olin is about project based, hands-on stuff, it is minus so much context ... I see this in all my friends when they graduate and they're like, "oh yes, this isn't engineering as it was pitched to me at Olin". (Jesse Walker, 2017)

I just think it's funny, like I'm not remembering specific courses or teachers or anything, when I'm talking about education. (Peter Webb, 2017)

However, even though these graduates do not articulate the point at which they learned something (or learned how to do something) there is a notable strand of professionalism in how they approach their working lives. For example, Peter Webb, talks about his current role in a small software company.

I've had to write a lot of emails explaining to people, 'Don't write code like this, because it'll cause these sorts of bugs.' I've also had to do unit tests and just general testing and stuff. They are smart people: I won't deny that. But there's some common-sense stuff. Like one of my co-workers ... none of his code is commented. There are well over 100 files. ... I was like, "Seriously?" (Peter Webb, 2017)

Peter's reaction to this situation is not that of a novice. He knows what good practice is, and works with colleagues to move the company towards that.

This attitude of professionalism is not confined to technical skills. Susana Clinton started her career at a major software company in a project management role.

So I also feel like I've probably gotten better at convincing people. Holding people accountable. Presenting my ideas clearly. Distilling information down for somebody who has no context of my area, which is both my leadership team and also new partners. So, it's a different kind of learning now. (Susana Clinton, 2017)

In fact, the clearest theme that emerged from the second interviews was that of continued learning, and this had several aspects. Firstly, there was the translation of learning from education to work:

I think in college you think that after college you're done learning. (Ashley Hayes, 2017)

As a student you call it learning but as an employee you call it professional growth. (George Andrews, 2017)

But secondly, learning had importance to them for their own well-being and sense of self, especially in its absence:

It certainly feels like I am learning more, and I'm doing things that are new and that are difficult, but it also still doesn't feel like I'm getting as much from it as I would like to. (Samuel Cline, 2017)

I am bored at work, like every day. So I spend a lot of time sitting here being like, "What can I do next that's going to get me to the next place?" ... I'm feeling like if I just sit here and do this work every day I'm going to go backwards, I'm going to forget everything, (Irene Luna, 2017)

Perhaps because they had always identified themselves (and been identified by their education) as learners, learning for its own sake was often praised.

I do really love diving into things and making things or tinkering with things. I think I get frustrated by that because I don't feel as free to dive and tinker ... at work you can't really be like, "I'm doing this because it's a good learning opportunity." (Evelyn Finn, 2017)

It was also striking that several participants singled out metacognitive skills for special mention. Both Evelyn and George particularly associated reflective skills with their education.

I really love the type of reflection you do at Olin where, at the end of something, you say, "Okay, what did we like about this? What can we change?" (Evelyn Finn, 2017)

That's where I think things like Olin have been so valuable because you are constantly thinking about, "What have I learned from this situation?" and how to do things differently. It's surprising how many people *don't* look at experiences and situations in that regard. They just look at it as it happened. They want to move on and get to something that will hopefully be better. (George Andrews, 2017)

Perhaps because metacognition as a disposition is non-specific, their recollections here contrast starkly with the quotes at the start of this section, where participants did not make, indeed felt unable to make, an explicit link between their college education and the work they were now engaged in. And there is an echo of that earlier, in George's recollection of the value of what he learned in high school.

Public speaking certainly didn't have any content to learn. It's even questionable whether that really helped me with any college admissions or things that were important at the time. But the skills and mentality that I learned from those events have lasted me longer than AP Physics did. (George Andrews, 2017)

Conclusion

The work in this chapter is limited in its situation in non-traditional, elite education. However, the re-positioning of these students' undergraduate education in the wider context of their learning trajectories may be applicable to graduates of more than a single institution.

Re-interviewing as a method, as in rephotography "... involves the presentation of sequential image pairs, in which the second modifies and expands our understanding of the first" (Berger 1984, p.46). Just as photographs of the "same"

scene taken years apart expose different changes, the re-told narratives exposed several characteristics. One is that the “chapters” the participants identify are malleable. Sometimes a vivid episode in the past is repeated essentially verbatim; at other times, experiences that had covered much of a person’s story become compressed to a single chapter, have become differently important, or are even omitted. The other is that, despite having recently graduated, Olin was not necessarily prominent in their narratives – and when they did talk about it, their stories were rarely about the ways in which it prepared them for work. Additionally, common themes emerge in regard to the acquisition and use of disciplinary knowledge across the transition of education to employment.

The previous chapters provided evidence of a longitudinal construction of gradueness, this chapter contributes a classification of the kinds of changes that occur in participants’ stories. As Rosenwald and Ochberg write: “How individuals recount their histories – *what they emphasize and omit*, their stances as protagonists or victims, the relationship the story establishes between teller and audience – all shape what individuals can claim of their own lives.” [emphasis added] (Rosenwald and Ochberg 1992, p.1) These interviews then start to show how graduates make continuing sense of their learning.

Emergent Observations on Institutional Differences

The work in this thesis has been interested in participants' learning experiences within their wider trajectories to characterise gradueness. The central concern is not with a generic construction of gradueness, which all graduates develop regardless of their individual experience, but rather gradueness as a construct that emerges longitudinally and in reflection. The work with Kent and Olin graduates affords insight into how far these trajectories are influenced by particular institutions and how much trajectories are characteristic of the institutions they attended.

Insofar as certain graduate outcomes are characteristic of particular institutions, this is also of interest to employers, who may prefer graduates from a certain institution, or a certain type of curriculum. As one employer noted in an interview for a report on employability in computing:

“Well I use their CV to gauge what course they’ve done and then I go and look at the University to try and find the curriculum to see if I can gauge how much science there was. I tend to find the ones that had just done ‘computing’ tend to be very hands-on and less theory, we tend to be more theory-led, because we’re doing the research.” (Fincher and Finlay 2016, p.89)

Employers also sometimes deliberately seek out graduates from specific universities, particularly if they have had positive experiences with graduates from the same institution before.

“I looked at the previous two years, at where we were getting the grads from, which unis they were coming from. I took the top four and

approached them and asked if I could come and speak. It [building a relationship between the company and universities] went from there.”
(Fincher 2017)

In this, graduates come to represent their institution. As a member of the SIGCSE (Special Interest Group on Computer Science Education) mailing list wrote:

“Like it or not, employers look to the CS degree as an indication that a student can write software, a skill that companies really want. When I worked in industry, if we interviewed a freshly graduated candidate for a software position who could not write code, we would be cautious about other students from the same school. And if there were more than one that flopped in the technical interview, we would just start screening out candidates from that school.” (MacKellar 2017)

Employers then recognise that graduates from different institutions are not alike. They identify which kinds of graduates – with which skills – suit their needs and adjust their recruitment accordingly. This suggests that there may be institutional differences in gradueness.

This brief interstitial chapter considers emergent observations from the two different contexts examined in this thesis, the University of Kent and Olin College of Engineering. It follows Ching and Vigdor in their goal “... not to strictly compare these two groups to one another, or to establish some quantifiable conclusion about their differences, but rather to open up new questions”, in this case about how different institutions affect individual learning trajectories (Ching and Vigdor 2005, p.2). Indeed, looking back over the three different studies in this work, additional themes emerged in relation to how

participants looked at what they learned and how they saw the purpose of an education.

How they look at what they learned

While Olin graduates repeatedly mentioned teachers and courses from high school, particularly in the first interviews, there was almost no discussion of courses they attended and disciplinary knowledge they acquired as part of their Olin education. The course most often mentioned (and that only four times across all interviews) was the mandatory second-year user-centred design course (UOCD). This course, with its focus on identifying user needs and developing ideas to make a difference in the lives of a user group, is particularly characteristic of the Olin education. After the common first year experience, it is also the first time all students take a class together at the same time again.

... UOCD was such a pivotal point, where I went from, “I’m going to leave Olin,” to, “Maybe I can do this shit.” (Irene Luna, 2017)

I found this love for design. Olin’s curriculum is so heavy on design, you don’t realise it. ... UOCD opens your eyes to everything making sense. ... You see the difference in the way that we work on teams and the way that we analyse problems, scoping them out fully. The way we think about how – instead of diving in – thinking about everything beforehand. Thinking about the users and their needs. That, to me, is the most important part of the education that we are getting right now. (Natalie Lee, 2013)

In contrast, graduates from Kent frequently recounted specific content and sometimes also mentioned the lecturers who taught it.

I did things like working out the Universal Gravitational Constant, and lots of maths that I didn't really understand. (Anthony Gibbs)

I remember there was a lot of stuff about the Automator, your DFAs versus NFAs, and propositional logic and stuff like that was all new. (David Bruce)

There were some other courses taught by certain other people where a combination of the material and the way it was taught left me extremely cold; somebody talking to me in a lecture about address buses on a 386 chip. Now, I know it was about that because he said "address bus" a lot, but I really didn't understand anything beyond that. (George Collins)

Probably one of the worst topics for me was – I can't remember what the course was called, but it was formal logic. It was things like Z notation, and using Z notation as a formal specification language. (Henry Summers)

I remember one course, ... it was done in the guise of a course on compilers. Basically, they gave us a compiler in Pascal with some bugs in it and told us to fix it. ... That was a really powerful experience. (James Clarke)

I got through the exam, but I didn't really become someone who understood maths any better than before; I just learned by rote ... the processes of whatever, Poisson distribution, and all this stuff. (Nicholas Bradley)

These examples were often described as material students were expected to learn – even if they did not always see the benefit. As in study 2, this is

Accountable Disciplinary Knowledge, exposed through the tension between students' expectations and what the university says they need to learn.

This kind of tension was not present in the Olin interviews. This is not explainable by a lack of course requirements: While the mathematics and physics requirements (such as vector calculus, linear algebra, differential equations, and electricity and magnetism or mechanics) are sometimes offered in an interdisciplinary format, they remain mandatory for all students. Yet, there was no mention of them in the interviews.

The closest expressions of ADK at Olin could be found in the interviews with Natalie and Leon.

So then Olin was interesting, because I was finally in a place where it was not about competitiveness. It was all about collaboration. It was about, *"We've got to get this thing to work or try to get this thing to work."* Or, *"We're all struggling through this problem set and this sucks, and E&M [a course on electricity and magnetism] is stupid and what are these teachers doing, because they don't know what they're doing and they said they don't know what they're doing."* (Natalie Lee, 2017)

Taken on its own, Natalie's description of the problem set could be interpreted as tension similar to that expressed in the Kent interviews. However, in the full context, it becomes apparent that she uses this episode to highlight the lack of competitiveness at Olin. There was a similar expression in the interview with Leon:

Then in the more traditional academic sense, [at Olin] I started having classes where it wasn't, *"Here's your problem set. Here's your lab. Go do the*

steps. Come back with a set of answers and I'll see how right you were." It was, "Hey. You need to learn these eight things. You've got all semester to do a project to do that. I'm not going to give you a lot of guidance on how to get there but you're going to have an experience." That was new to me.

Not having a structure. Not having a right answer. Not having a set of criteria that defined whether or not I was passing or failing was kind of the exact opposite problem that I had had in seventh grade. It was very difficult for me. Especially in UOCD. ... I kept thinking, *"There has to be a better system for this. I have no idea what's going on at any point in time. You're using all of these terms that I've never heard before. You're not teaching me anything. You're just telling me to do things."* I didn't have a great idea of why I was being asked to make a mood card board and stuff like that and I hadn't realised yet that part of the experience was figuring that out for my Goddamn self. (Leon Clay, 2017)

Again, Leon's description of the mood card board could be seen as an expression of ADK, as something he was asked to do by his instructors, and he is clearly ambivalent about the user-centred design course. However, similar to Natalie, he uses this description to draw a contrast to his prior learning experiences where he was explicitly told what to do. While these two excerpts then resemble ADK at a first glance, they are very different from its expression in the Kent interviews.

How they see the purpose of an education

Graduates' reflections on what they learned at university were intertwined with their views of the purpose of their undergraduate education – and Kent and Olin graduates had different views of this. While the Kent graduates had different

views of whether the course itself was useful, the purpose of going to university was about preparing them for the work they wanted to do after graduation.

... everything that I learnt in the second and third year, was very, although it wasn't intended to be a vocational course, I have used almost everything that I have learnt in the second and third years, over my career. ... There's nothing that, there's none of those courses that I felt were wasted. (Anthony Gibbs)

I felt like it wasn't relevant to what I wanted to learn. It's kind of the typical criticism of academia. It's in its own little world of stuff that's not particularly relevant to real world computing. ... there didn't seem to be any point to the code we were writing. I think I wanted to learn to be better at programming and about using computers. Instead I was learning things which seemed esoteric at the time, and very formally driven, perhaps too formally driven, and didn't really relate to things that I thought I would be doing when I left university. (Henry Summers)

Many of them were eager to specialise and learn skills related to the profession they saw themselves moving into.

It was learning because this stuff was interesting, learning because I knew that I could get a job from this at the end of it. (John Warren)

That was what I came for, the more advanced bits of the discipline and stuff I wouldn't have picked up myself and actually now are trying to learn more of. (Michael Hyde)

And when they did not feel that the university was preparing them appropriately (as expressed in the tension surrounding ADK), they were disappointed and considered seeking a job instead of continuing with their university education.

In terms of dropping out – it was dropping out to just go and get a job as a programmer, rather than continuing with the course, which I didn't think was benefiting me much. (Henry Summers)

The stories the Olin graduates told about graduating, about what they considered a university education to be for, had a different quality – they all had jobs, but were often unsatisfied and felt constrained. They frequently expressed this as not wanting to get “stuck”.

The fourth chapter I titled “specialisation” because that's going out of an academic environment, which always has an inherent value for learning for learning's sake and you are very much the product of the experience. Then moving into a professional situation with a job where there is an exchange between the employer and employee and a need from the employer's perspective that you become an expert in certain fields and can be worth the investment in the particular job you were hired to do. (George Andrews, 2017)

One aspect of this constraint is simply the demands of a job, expressed in what an employer expects a new employee to learn. Henry Summers, the Kent graduate, also observes this.

It's kind of learning on the job, and it's developing the skills I had and learning new skills, but everything here is learning to achieve something else, some other aim. So learning some skill because it's part of what I did

with my job or would make my job easier. Everything is ultimately financially driven. So anything I want to improve at is because it helps me get a better job, or keep my job, or that kind of thing, because it's part of the job I've been hired to do. (Henry Summers)

Both George and Henry speak in strikingly similar terms about learning “as part of the job I've been hired to do.” Henry embraces this specialisation as part of his job. However, in George's view, this is more problematic:

Trying to keep a broad and strong base from which you can move in different directions I think is important or necessary. If you overspecialise, then you quickly end up on a path where if you don't like where it's going, you now have to backtrack: “That's another three-year cycle that you lost.” (George Andrews, 2017)

While both Kent and Olin graduates describe continued learning experiences after graduation, the Olin graduates appear to “push back” against this specialisation in the workplace.

For another graduate, Ashley, specialisation did not emerge as a concern in the workforce, but was already to be found while at Olin.

... so much of my learning story is all about exploration and learning so much, ... [that] the idea of specialisation, even by the time I was at school [at Olin] with only engineers, which you could argue is quite specialised, I think I was pretty terrified of specialisation, honestly, because I felt ‘in a corner’ and limited. (Ashley Hayes, 2017)

Here, she situates her concern about specialisation in the context of her prior learning experiences before Olin.

After my first year, I did research with [two professors], and I think that was the first time I had done a more specialised thing,... because in the semester you are not really focusing on one thing for a long time. (Ashley Hayes, 2017)

The first-year curriculum at Olin is purposely kept broad, exposing students to classes from different fields and often introducing technical knowledge just-in-time, and Ashley's locates her first experience of specialisation in a research project during the summer vacation.

Both Ashley and George noted in their interviews that they were coming to terms with this development – though sometimes reluctantly – and both named the chapter in their learning life after their time at Olin “specialisation”.

There is certainly, I think, a sadness about the specialisation. You know, one of the great things about school is that you do have opportunities and expectations to learn different things and be tackling different fields. Obviously, in a professional context, that branching out is either not possible or not valuable. So, it's kind of coming to terms with the specialisation and needing to be excited about becoming an expert of this thing that you're doing while still trying to find ways to continue learning outside of that. (George Andrews, 2017)

George attributes being unable to acquire the breadth he seeks to the demands of his job. But while he adopts a largely negative perspective, Ashley expresses a slightly different view:

I think over the past three years [since graduation], I have struggled with that quite a bit until it started to come out to be like, “No, specialisation isn’t a limitation,” and especially if you are the type of person who loves learning a lot of things. If you have that, and you also have very deep skills, then you are a huge resource and it is easier to learn more subjects, and it is easier for you to help other people. (Ashley Hayes, 2017)

In this, she recognises that there are benefits to specialisation in her field which may be useful to other people on her team.

The *fear of specialisation* in the interviews with Ashley and George also emerged in different ways in interviews with other Olin graduates. For instance, Susana Clinton, who works as a project manager at a large software company, also notes it, though she did not express the same fear as Ashley and George.

I have no depth in anything, currently, which I’m actually kind of okay with. Because I have been learning like a sponge, the breadth has come naturally.... (Susana Clinton, 2017)

The skills she describes using are also different from those the Kent graduates discuss.

So I also feel like I’ve probably gotten better at convincing people. Holding people accountable. Presenting my ideas clearly. Distilling information down for somebody who has no context on my area, which, both is my leadership team and also new partners. So, it’s a different kind of learning now. (Susana Clinton, 2017)

The fear of specialisation identified here took several forms. Although the most common was the simple expression of being “stuck”, it is manifested differently in Jesse Walker, who worked in a number of different jobs after graduation, including at a supermarket.

I can say that this stuff I’m working on [now] is more interesting, but the working environments aren’t necessarily any less interesting. I’m typing instead of slicing meat but at any given time, I can still have an interesting conversation with a co-worker. (Jesse Walker, 2017)

He is not upset by this experience, despite holding an engineering degree from an elite university. Indeed, he sees value – and finds happiness – in the experience and describes rewarding interactions with co-workers at the grocery store. Jesse deliberately sought out work that did not draw on the skills he acquired as part of his university education.

I basically said to myself, “Once I graduate, I’m going to take the time to do a few more jobs and I’ll do some part-time stuff.” Even work at the supermarket and give myself this time to orientate myself towards working without any form of taking advantage of a degree I had in my hand. (Jesse Walker, 2017)

However, the Olin graduates have only spent the first few years in their careers to date, their perspectives may change in the future, whereas some of the Kent graduates graduated a long time ago. This fear of specialisation may then be specific to these students (or this type of student), characteristic of Olin graduates more generally, or it may be associated with the transition to the workplace.

As we saw in study 3, the Olin graduates were occupied with finding broader learning opportunities, at times outside the job. And in terms of their undergraduate education, the *content* of their course was ultimately unimportant for them, to the point that they found it hard to recall concrete details of material or teachers. (This may be because they were extremely able students on entry to university, and confident of their ability to learn, essentially, whatever they wanted to.) The “take away” for the Olin graduates is lodged in their attitude to learning and associated metacognitive skills. As one participant says, “... If you were to take Eighth Grade me and dot me in the world, I would be okay. But I probably wouldn’t be as prepared to continue learning and motivate myself as I felt after Olin.”

Other students, students from other institutions, may not show the same attitude. There is then suggestive evidence of the influence of the institutional context – that we may be beginning to be able to characterise institutional differences in *graduateness*.

Of course, there are also other aspects that influence graduateness, such as the institutional intake: Students choosing to attend Kent and Olin may be predisposed and attracted to parts of the offer by virtue of their prior learning experiences. Graduateness, in the construction proposed in this thesis, is the result of graduates’ cumulative learning experiences and sense they make of them. Formal education almost always consists of the same material presented to all students in a class at the same time, without regard to their backgrounds or previous experiences. But for the student, what goes before (and comes after) learning is not dissoluble, a student cannot “un-have” an experience, or have a different schooling or a different preparation; this construction of graduateness reflects that, and the narrative and longitudinal methods used in this thesis afford explanation of how it evolves over time.

Discussion

Contributions

This thesis makes contributions by proposing a narrative construction of gradueness that is grounded in graduates' experiences. It is further illuminated by three analytical constructs (turning points, boundary objects, and autobiographic authority), includes ADK as a personal construct, and is constantly reconstructed in the light of new experiences. These aspects of gradueness emerged through the combined use of different analytic approaches. This chapter discusses these individual contributions and the questions they raise, before turning to the limitations of this work.

1. Narrative Construction of Gradueness

In their longitudinal study of student transitions at university, Christie and colleagues write that "learning is not just about how students meet the requirements demanded of them at specific points in their academic career, but is embedded in the totality of their prior learning experiences" (Christie et al. 2016, p.480). This thesis has adopted a similar perspective and proposed a narrative construction of gradueness that centres on students' individual experiences and the sense they make of them. Gradueness, then, as part of a person's life story, is constantly reconstructed and incorporates learning experiences from the past and present, together with beliefs and expectations about the future.

This sort of continued construction is significant because the value and purpose of an education is not just in the moment but emerges over time. As one of the study participants noted:

I think the thing that is quite common is that you are always, always learning. ... Your vision of what you want to learn can only come from you. What you learned two years ago is probably going to mean nothing to you now - but at the same time what you did learn serves... It's like layers isn't it? Where each thing is like a foundation layer for the next thing. And I guess that ... if you look back at everything I have done, each thing provides the underlying layer for the next thing. (Nathan Baker)

Another participant similarly narrativises the idea of a career in a way that highlights its longevity.

... your career, or a career, is a marathon. It's not a sprint. ... You've got to pace yourself, and you've got to build on, you've got to do the hard yards and you've got to build on that long-term. Don't try and rush them. (Thomas Jarvis)

This construction of gradueness differs from traditional approaches used to assess the effect of a university education: It does not use quantitative methods but reflects the nuances in graduates' individual experiences and the sense they make of them. Additionally, in contrast to earlier longitudinal work on student identity development (e.g. Josselson 1987; Baxter Magolda 2001), it is also grounded in disciplinary and institutional contexts.

2. Methodological Plurality

This thesis has provided an overview of narrative methods (in chapter 2) and examined how they have been used in computing education to date. As storied approaches are not commonly used in computing education research, this work contributes a new perspective to the field.

Each of the studies presented here uses a different analytic approach within the context of narrative methods: Study 1 (in chapter 3) examined graduates' experiences across multiple lives using a traditional thematic analysis. Study 2 (in chapter 4) adopted a case-based approach to explore individual participants' trajectories in more depth and to examine similarities and differences in their experiences. Study 3 (in chapter 5) relied on a more traditional approach but contributed a longitudinal perspective using the concept of re-interviewing. This methodological plurality exposes different aspects in participants' narratives.

3. Analytical Constructs in the Year in Industry

Study 1 identified the Year in Industry as a particularly influential element in participants' learning life stories. In this, the concepts of turning points, boundary objects, and autobiographic authority were adduced to mark important points in their experiences and provide additional explanatory power to understand graduates' experiences in computing both during the Year in Industry and as they return to university.

4. Accountable Disciplinary Knowledge as a Personal Construct

The concept of Accountable Disciplinary Knowledge has been newly characterised as a personal construct in study 2. The original work on ADK by Stevens et al. acknowledged the role of internships but otherwise focussed exclusively on students' experiences and identity formation at university (Stevens et al. 2008). This work extends ADK beyond their construction in a university setting into the workplace. Students' learning trajectories do not end with graduation. Graduates, both from Kent and Olin, spoke of their continued learning experiences, and the extended construction of ADK proposed in this thesis reflects that.

5. Classification of Twice-Told Stories

Study 3 used the method of re-interviewing to examine the evolution of participants' stories of their learning experiences. This is a relatively unusual approach, as there is little existing work that examines participants' constructions of life stories over an extended period of time. Most existing work remains focussed on individual stories re-told in conversational settings (Norrick 1998). This work contributes a classification for twice-told stories and has shown how graduates re-fashion their learning life in the light of new experiences as they move from university into the workplace.

Questions Raised

The qualitative, narrative approach used in this thesis means that although aspects of this work are relevant to other contexts and disciplines, many may be specific to the environments studied. Nevertheless, there are several broader questions this work raises.

Both the narrative construction of gradueness and the typology of twice-told stories presented here have implications beyond the context of computing education. The narrative construction of gradueness permits a wider view about the effect of a university education. It moves beyond commonly used short-cycle methods for the assessment of the effect of university degree programmes (such as end-of-term surveys) and exposes the lasting value of an undergraduate education. In this, it may present both a more considered and more effective way of evaluating such programmes. The classification of twice-told stories provides insight into how graduates re-fashion stories of their learning experiences and how their meaning evolves over time.

Other contributions – such as the analytical constructs of transitions and turning points, boundary objects, autobiographic authority, and the concept of ADK – have specific implications for computing education practice and are enumerated here.

Transitions

Transitions between different environments present particular opportunities for the development of new learning experiences: There are new forms of industry engagement emerging in the higher education sector which reconsider traditional boundaries between academia and industry. As Fincher and Knox write, “... computing curricula have historically separated academic learning from professional practice in cooperative placements or internships. However, the classroom is not hermetic: there is a rich continuum of possibilities for exposing students to the different requirements—and rewards—of work-based learning within the educational environment.” (Fincher and Knox 2013, p.44) A recent example of this is the UK *Graduate Apprenticeship* model which has become increasingly popular and as part of which students work for a company in parallel to their studies of a defined curriculum.

Study 1 also highlighted the significance of the Year in Industry in graduates’ learning trajectories and suggested that students’ return to university following their time in industry may be a particularly important part of their experience. As well as universities paying attention to times of transition into and out of placements, this focus may also be extended, for instance by examining the transition into the workforce for those graduates who did not complete a Year in Industry.

Turning Points & Boundary Objects

The other constructs identified in study 1 are also relevant to computing education, however not in a literal way. Boundary objects, which were observed across students' transitions as they returned from the Year in Industry, cannot simply be "given" to students. Instead, the emergence of boundary objects may indicate specific points where attention is warranted (e.g. between years of study or upon graduation). Similarly, while turning points can provide valuable insight in identifying significant experiences, instructors cannot guarantee that a particular course, lesson, or experience will become a turning point for students, as they are individually constructed and only emerge in retrospect.

Autobiographic Authority

With regard to autobiographic authority, there are two implications. First, it is important for academic departments to recognise the influence of placement programmes on students' experiences. Practically, this means developing curricula and interventions that avoid the pitfalls exposed in Auburn's study of psychology students who, upon returning from their placement year, did not feel that they could incorporate their experiences (and newly found authority) back into the academic environment (Auburn 2007). Second, it means recognising and implementing alternative ways of exposing students who do not have the opportunity to take part in a placement year to authentic practice, for instance through short-term placements, industry fellows, sponsored projects, or student-run software clinics (Fincher and Finlay 2016).

Accountable Disciplinary Knowledge

Finally, in terms of ADK as a personal construct, it may be useful for academic programmes to encourage the internalisation of ADK. For instance, universities could draw on principles of problem and project based learning (Blumenfeld *et al.*

1991), provide students with greater autonomy in choosing courses in their final years, and emphasise and promote the development of metacognitive and reflective skills.

Limitations

As with any research project, in addition to any contributions and questions raised, there are a number of limitations and opportunities for future work.

Quality in Qualitative Research

Studies employing quantitative methodologies commonly rely on the concepts of internal validity, external validity, reliability, and objectivity to establish the quality of the research (Lincoln and Guba 1985). However, several researchers have suggested that credibility and trustworthiness are more appropriate warrants for quality in the context of qualitative inquiry (Lincoln and Guba 1985; Mishler 1990; Mishler 1991; Kvale 1996). Lincoln and Guba developed a widely used framework to determine trustworthiness consisting of four components – credibility, transferability, dependability, and confirmability – which mirror their quantitative counterparts (Lincoln and Guba 1985). The following draws on this model and considers each of its components in turn.

Credibility

Credibility is characterised as confidence in the truth of the findings presented (Lincoln and Guba 1985). The work in this thesis has relied on established research methods, triangulation, and member checking to ensure credibility.

The narrative approaches used in this work are well established in other fields, such as anthropology, psychology, and sociology (Clandinin 2006). The life story interview has been used extensively in psychological research (Adler et al. 2017)

and modified versions for teaching and learning have previously been used by the Share Project (Fincher 2012) and in the pilot study of this work (Dziallas and Fincher 2014).²⁰ Additionally, concepts such as Accountable Disciplinary Knowledge were originally developed in the related field of engineering education research (Stevens et al. 2008) and have since then been used in computing education research (McCartney and Sanders 2015).

The methodological plurality of narrative approaches has provided a form of *triangulation*, as several key aspects emerged across contexts and analytic approaches. For instance, the concept of Accountable Disciplinary Knowledge initially emerged in study 1 in the context of autobiographic authority. Yet, study 2, using an entirely different analytic lens, also exposed ADK in participants' narratives and chapter 6 observed differences between Kent and Olin graduates' narratives.

Member-checking describes the process of sharing interview transcripts and the resulting interpretations with participants (Lincoln and Guba 1985).

While the interview transcripts were not shared with participants as a matter of course, participants were sent any resulting publications, if requested. In the re-interviews, a few of the Olin graduates also expressed interest in reading their original interviews after the re-interviews. These transcripts were shared when asked.

²⁰ The students in the pilot study talked extensively about their experiences prior to entering higher education. This preceded the work presented in studies 1 and 2 with graduates from the School of Computing at the University of Kent, which was conducted in the hope to elicit their learning experiences in computing over time, *including* at university.

In terms of recruitment and sampling, 35 out of 105 respondents from the University of Kent were interviewed. There was no additional sampling criterion beyond the inclusion of a broad range of graduation years. For the study at Olin College, all twelve respondents were included in the study. While it is possible that graduates who responded to the solicitation may have self-selected (either because they were particularly inclined to tell stories or because of a positive or negative experience at university), graduates generally did not appear to have such an “agenda” and some explicitly expressed appreciation for the opportunity to reflect on their learning experiences.

The number of participants in the studies presented here – 35 from the University of Kent and 12 from Olin College – is also relatively small, though this is not uncommon in this kind of qualitative work. In the cohort from Olin College there were only six graduates who took courses or pursued a career in computing. Graduates from the University of Kent came from a wide range of cohorts, with some having graduated as early as 1985 and others as late as 2015. This provided insight into the evolution of the academic programme at Kent. However, it also meant that there were few participants from each intake. Another limitation is that only three women participated in the study at the University of Kent. Unlike in the study at Olin College, where women were roughly represented in the same proportion as in the student body, this is a lower percentage than in the cohort at Kent.

Transferability

Transferability describes in how far results are applicable in other contexts (Lincoln and Guba 1985). The work in this thesis has been limited to two institutions, the University of Kent and Olin College of Engineering. These are very different institutions, with different aims, curricula, learning environments, and student intakes. While chapter 6 focussed on emergent differences between

the stories graduates told about their learning experiences, more data from other universities would provide additional insight into which elements identified in this may be general or are specific to these two institutions.

Transferability in qualitative research is commonly achieved through “thick description” (Lincoln and Guba 1985), which was first defined by Geertz (Geertz 1973). Thick description does not necessarily refer to long and detailed accounts. Rather, as Tenenberg (in press) writes, “Thickness has to do with understanding and making visible the specific ways that a person or culture constructs and shares meaning.” This work has drawn extensively on interviews with participants and has provided additional context about each learning environment to address concerns of transferability.

Dependability

Dependability refers to the consistency of the results (Lincoln and Guba 1985). As Nowell et al. write, dependability requires the research process to be “logical, traceable, and clearly documented” (Nowell et al. 2017, p.3). Such evidence also provides the material for an *external audit* – a way for others to assess the quality of the research – as suggested by Lincoln and Guba.

This work has provided detailed descriptions of the research process, including about the prompts used and participants’ demographics, in order to make the analysis transparent. This allows other researchers to follow the same procedures and is particularly important in study 2 (in chapter 4) which adopts Mishler’s case-centred approach and includes aspects of interviews that are commonly discarded.

Another strategy identified by Lincoln and Guba to address the dependability of research is through triangulation of methods (Lincoln and Guba 1985), which has been described in the section on credibility above.

Confirmability

Confirmability describes efforts to limit the influence of researcher bias. With regard to the Olin graduates, I had a unique relationship to the institution, and the participants, as I had graduated from Olin myself in 2014. As Sally Fincher and I wrote in 2014 in a paper reporting on the original pilot study with participants from Olin (who were then students themselves):

“interviewer and participants jointly entered the institutional frame of thought as they recalled memories. Thus, assumptions about the context of the college, though an essential part of the narrative accounts, were rarely explicitly articulated (Cook-Gumperz 2011). However, our interpretive thematic approach permits us to explore the different narrative layers in relation to each other, as themes emerge from the repeated reading of the accounts.” (Dziallas and Fincher 2014, p.829)

Of course, as Walther et al. observe, “the researcher is always connected to and, to some degree, influences and is influenced by the social situation under investigation” (Walther, Sochacka and Kellam 2013, p.633). In this instance, I had particular insight into the students’ learning environment, which allowed me to achieve a closer understanding of their experiences. Where participants indicated in the interviews that I was already familiar with the context, I nonetheless encouraged them to make it explicit. Nevertheless, in regard to Olin, mine was a privileged perspective and may limit other researchers’ ability to reproduce these results.

However, the interpretations presented here – particularly surrounding the analytic constructs in study 1 and the themes in study 3 – are the result of an open coding process, as part of which concepts are identified and named in repeated readings of the interview transcripts (Strauss and Corbin 1990). This approach is commonly used in qualitative research to open up the text “in order to uncover ideas and meanings it holds” (Given 2008). In reporting the findings, this work presented detailed quotations that preserve participants’ voices. In addition, the inclusion of self-signification, in particular through participants’ naming of chapter titles and identification of common themes in their stories, means that this work does not exclusively rely on the researcher’s interpretation.

Lincoln and Guba have also proposed an audit as a way of addressing both dependability and confirmability (Lincoln and Guba 1985). While there was no full external audit conducted in this work, studies 2, 3, and 5 are based on material published at the *International Computing Education Research* conference and, in this, have been exposed to peer-review (Dzallas and Fincher 2016; Dzallas and Fincher 2018). This acceptance in the research community is another warrant for quality (Kvale 1996; Walther, Sochacka and Kellam 2013).

Future Work

There are several opportunities for future work: Potential future efforts could involve similar work with graduates at other institutions and in other countries. Indeed, the work in this thesis – both at Kent and at Olin – was conducted in a Western context. As people tell stories differently in different cultures, work to obtain life stories in different contexts would highlight similarities and differences in gradueness.

Study 2 (in chapter 4) showed the value contributed by stories from people who had not graduated from Kent, either because they moved to a different institution or left higher education entirely. This presents an opportunity to use this methodology with other “non-graduates” (cf. Seymour and Hewitt 1997), particularly, perhaps, in the context of students who leave non-traditional learning environments, such as at Olin College.

It may also be fruitful to return to the Olin participants again in the future. Indeed, some of the participants expressed curiosity in how their stories would change at a future interview. This would also indicate whether the fear of specialisation observed in chapter 6 has persisted in their working lives and provide further evidence of the ways graduates re-story their learning lives.

Appendix 1: Undergraduate Computing Degree Titles and Number of Graduates at the University of Kent

Degree Title (BSc where not specified)	Start Date	Year of Graduation																	
		'99/ '00	'00/ '01	'01/ '02	'02/ '03	'03/ '04	'04/ '05	'05/ '06	'06/ '07	'07/ '08	'08/ '09	'09/ '10	'10/ '11	'11/ '12	'12/ '13	'13/ '14	'14/ '15	'15/ '16	'16/ '17
Business Computing	01/08/2005									6	<5	7	<5	<5					
Business Computing with a Year in Industry	01/08/2005										<5	<5	<5	<5					
Business Information Technology	01/09/2004								<5	6	11	16	6	23	19	26	10	13	27
Business Information Technology with a Year in Industry	01/09/2004								<5	<5	<5	7	5	13	20	<5	8	13	14
Computer Science	01/01/1980	70	64	51	59	46	48	61	47	38	30	42	29	32	18	35	29	36	56
Computer Science (MEng)				<5	<5	<5													
Computer Science & Management Science with a Year in Industry	01/09/2004							5	<5	<5	<5		<5		<5	<5			
Computer Science (Artificial Intelligence)	01/08/2009													<5	<5		<5	6	<5
Computer Science (Artificial Intelligence) with a Year in Industry	01/08/2009														<5	6	<5	<5	6
Computer Science (Business)	21/01/2009													<5	<5	<5		<5	

Computer Science (Business) with a Year in Industry	21/01/2009															5			
Computer Science (Consultancy)	01/08/2008													<5		<5		<5	
Computer Science (Consultancy) with a Year in Industry	01/08/2008														<5		<5		
Computer Science (Networks)	01/08/2008														<5		<5	<5	5
Computer Science (Networks) with a Year in Industry	01/08/2008													<5		<5		<5	<5
Computer Science and Business Administration	01/10/1997	8	6	8	<5	12	6	6	5	<5									
Computer Science and Business Administration with a Year in Industry	01/10/1997			<5	<5	<5	<5	5	<5	<5									
Computer Science and Management Science	01/09/2004					<5				<5		<5		<5					
Computer Science with a Year in Industry	01/01/1980	10	<5	12	42	31	48	51	64	43	40	43	29	40	54	50	70	68	65
Computer Science with Artificial Intelligence	01/08/2006										<5	<5	<5	<5	<5				
Computer Science with Artificial Intelligence and a Year in Industry	01/08/2006											<5		<5					
Computer Science with Management Science	01/01/1980	<5			<5		<5												
Computer Science with Management Science and a Year in Industry	01/01/1980				<5	<5	<5												

Computer Systems Engineering (BEng)		22	23	<5															
Computer Systems Engineering with a Year in Industry (BEng)			5																
Computing	01/08/2012																<5	10	17
Computing (Consultancy) with a Year in Industry	01/08/2012																<5		<5
Computing and Business Administration	01/10/1998		7	11	16	15	17	12	<5	8	<5	<5	<5	<5	<5	7	5	12	6
Computing and Business Administration with a Year in Industry	01/10/1998			<5	7	6	<5	<5	5	<5	<5	<5	<5	<5		<5	<5	<5	6
Computing with a Year in Industry	01/08/2012																13	<5	9
Computing (Consultancy)	01/08/2012																	<5	
European Computer Science (MComp)	01/01/1980		<5				<5												
Information Technology	01/08/2005								<5	10	8	15	8	14	19	27	<5	5	<5
Information Technology (Consultancy) with a Year in Industry	01/08/2008														<5		<5	<5	
Information Technology (Software Engineering)	01/08/2008														<5	<5			
Information Technology (Software Engineering) with a Year in Industry	01/08/2008															<5			
Information Technology (Web Applications) with a Year in Industry	01/08/2008															<5			

Information Technology with a Year in Industry	01/08/2005									<5	<5	5	<5	<5	9	6		5	
Web Computing	26/09/2005									<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Web Computing with a Year in Industry	26/09/2005										<5	<5	<5	<5			<5	<5	
Grand Total		114	108	89	133	120	130	141	139	127	114	153	99	148	157	180	157	193	221

Appendix 2: Participants from the University of Kent

Name	Year	graduated	with a Year in Industry
Anthony Gibbs	1985	yes	no
Thomas Jarvis	1986	yes	no
James Clarke	1988	yes	no
Jacob Richardson	1990	yes	no
Jack Cameron	1993	yes	no
Jacob Faulkner	1994	yes	no
Scott Hyde	1995	yes	no
Ryan Watts	1995	yes	no
Christopher Hartley	1997	yes	yes
Henry Summers	1999	yes	no
Sam Howard	1999	yes	no
Tom Cooke	2000	yes	no
Taylor Long	2000	yes	no
Elliot Wheeler	2000	yes	no
Owen Bryant	2001	yes	no
George Collins	2001	no	no
Jordan Parker	2002	yes	no
Nicholas Bradley	2002	yes	yes
Michael Hyde	2003	yes	no
Peter Grant	2004	yes	no
David Bruce	2006	yes	yes
Melissa Bryan	2006	yes	yes
Alice Hayes	2007	yes	yes
Emily Briggs	2009	yes	no
Luca Boyle	2009	no	no
Luke Sullivan	2011	yes	no
Joe Stewart	2012	yes	yes
Joel Bailey	2012	yes	yes
John Warren	2012	yes	yes
Alex Barlow	2013	yes	yes
Nathan Baker	2013	yes	yes
Max Bradshaw	2014	yes	no
Benjamin Holland	2015	yes	no

Evan Lowe	2015	yes	no
Jake Mason	2015	yes	yes

Appendix 3: Participants and Chapter Titles from Olin College

pseudonym	year	chapter titles											
Natalie Lee	2013	{being bored in my kindergarten and my pre-school}			{Montessori}			{the IB program}			{Olin}		
	2017	School Learning				Working				Life Learning			
George Andrews	2013	the beginning		{the middle and high school experience}		{my experience at [private research university]}		Olin Part One		Olin Part Two		the summer internship experience	
	2017	Academic Performance		Independence		Reflection in Purpose		Specialisation		Proof and Pathfinding			
Samuel Cline	2013	Absorption			Taking the Red Pill			Enjoyment			Engagement		
	2017	Because I Have To			Discontent Brews		Understanding My Frustrations		Olin			What Now?	
Irene Luna	2013	Natural Learning			Easy Learning			Not Learning			Coming to Terms		
	2017	Learning is Easy	Learning is not a priority		I can learn what I want		Oh my God, what is engineering?	Learning is Mine		Learning What Matters		Lifelong Learning?	
Michelle Young	2013	{birth to third grade}			{[school programme for high achieving students]}			{[small town]}			{Olin}		
	2017	{school programme for high achieving students}		{small town}		Olin			{Eilane} Year One		{Eilane} Year Two		
Leon Clay	2013	Toys			Nerd Camp			{high school}			college		
	2017	Units	Thinking Before Speaking		The Wall		All About Those Grades		Figure It Out		PM Post-Grad		Not Doing What I'm Told
Kathryn Benz	2013	{pre-school}	{elementary school [1]}		{[elementary school 2]}		{middle school}		{[top magnet high school]}		{[public high school]}		{Olin}

	2017	Montessori School	[elementary school 1]	[elementary school 2]	Learning about Puberty	Going to [top magnet high school] and Dropping Out	Hating [top magnet high school]	Olin	Leaving College and Being in [major east coast city]	Transitionin g to Work and Living on Your Own	Re-Application of the PhD Program	
Peter Webb	2013	{home schooled}		{high school}		{[large public research university]}		{Olin}		{[Liveworks]}		
	2017	Home Alone		High School		My Year at [large public research university]		Olin		My Current Job and My Attempt to get into the [foreign language exchange teaching programme]		
Susana Clinton	2013	Preschool-6th gradeish		7-10ish grade		11-12 grade		Olin first semester		Second semester-now		
	2017	Sponge Learning			Foundation Learning			Preparing for Adulthood			Intuitive Learning	
	alternate	exploration			foundation			preparing			exploring	
Jesse Walker	2013	{elementary school}		{fifth and sixth grade}		{seventh and eighth grade}		{high school}		{Olin}		
	2017	Buying In				Part-time: Reorientation				Disorientation		
Ashley Hayes	2013	learning ethic formation	difficulty and disappointment	self-realisation		focus on the future	lots of awesome		real world problems		getting a focus	
	2017	Discovery		Lessons in Focus		Exploration		Solidification		Specialisation		
Evelyn Finn	2013	Free Reigns		Grades are a Thing		Nugget of Information		The Story of Evelyn Re-Learning Why She's in School		{Olin}		
	2017	Getting Hyped for School	Learning through Discovery		Learning as much as I needed to and doing the work		The Mad Dash		Learning By Doing from Passionate People		Making Your Own Learning Opportunities	

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