# "I told you this last time, right?": Re-visiting narratives of STEM education

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## ABSTRACT

The stories we tell ourselves and others – both as individuals and as a community – reflect how we make sense of our lives. Our work using narrative methods has explored how university graduates make sense of their learning experiences and how these fit within their wider learning trajectories. In this paper, we discuss work we conducted with a group of a dozen students who, when first interviewed, were in the second half of their undergraduate education at Olin College of Engineering. All twelve participants were re-interviewed four years later, after they had graduated, using the same narrative protocol that asked them to describe their learning 'life' as if it was a book, and to identify and describe individual chapters of their experience.

The pairs of interviews were analysed with respect to their form and their content. In regard to form, a classification of these repeated stories is derived. Thematic analysis of the content examines a) how students come to study and practice computing and b) the continuing, and changing influence of a university education over time, as students construct an individual sense of coherence.

## CCS CONCEPTS

• **Social and professional topics~Computer science education**

## KEYWORDS

narrative methods, qualitative research, longitudinal work

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## 1 INTRODUCTION

The work we present in this paper 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 [5, 14]. 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." [4]

We are similarly interested in changes that occur over time, in students' wider reflections of their learning trajectories and specifically how they incorporate their experience of higher education within that. While photographs are the medium that expose changes in the context of rephotography, we use narratives in our work, as they are an effective way of exploring how students and graduates make sense of their learning experiences [9, 28]. 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." [23]

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." [17] 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) across repeated elicitations [8, 20]. There are also a few CompEd studies that have examined students' identity development (e.g. [13], [33]), but they generally do not rely on narrative methods. For instance, Peters conducted a phenomenographic study using written reflections with students in two programmes over the course of three years [27]; McCartney and Sanders used semi-structured interviews a longitudinal study with American computing students [21].

In this paper, we are not concerned with "whole" identity – with the sum of what makes up a person – but with participants' "learning life", and with how the stories they tell about their learning experiences change over time. We present two separate parts: The first concentrates on form and identifies the ways in which stories our participants tell about their learning experiences have (or have not) changed. The second focusses on

content and explores graduates' reflections of their acquisition and use of disciplinary knowledge within and beyond their undergraduate education.

## 2 METHODOLOGY

We obtained ethical approval from the Research Ethics Advisory Group of the Faculty of Sciences at the University of Kent and conducted initial interviews with twelve students from Olin College of Engineering who were (with one exception) in the second half of their college education in the summer of 2013. There were seven women and five men among the participants. All participants volunteered by responding to an email solicitation sent to all students entering the third or fourth year of their Olin education; there was no deliberate selection policy (e.g. to obtain a stratified sample or the like). Four years later, the same interviewer re-interviewed all twelve participants (who had by then graduated) using the same prompt. This is an unusually high retention rate for work of this kind.

We use an approach developed by Dan McAdams. He argues that we, as individuals, construct an internal *life story*, which is part of our identity, to make sense of our lives [19]. He elicits these in a structured *life story interview* [18]. We use a modified version of the life story prompt, to focus on participants' 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.*

As part of the prompt, participants identified "chapters" in their learning lives. Life-story chapters elicited in this way have "identifiable beginnings and endings" [32] and, according to Steiner et al., "represent relatively stable autobiographical periods governed by overarching themes and goals" [31]. In titling their chapters, some participants simply name locations of their education, such as schools (and, later on, employers), whereas others use more interpretive names. For us, these chapters are a form of *self-signification*, in that participants – rather than us, as researchers – indicate personal significance in the name they choose [29]. In this, they sometimes reveal aspects of an experience that would not otherwise be apparent [9].

In some cases, interviewees did not explicitly name a chapter (for the first interviews, the interviewer was less experienced and did not always press participants to identify chapter titles). However, we can identify segments based on their descriptions, as the beginning and end points of each segment remain clear, even without a title. Where we have named a chapter, this is represented in curly brackets.

At the end of the interview, we then asked participants:

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

In both series of interviews, the prompt was sent to participants a week in advance, and some used this time to make explicit preparation. We purposely did not revisit the original interviews before the second intervention (and indicated this to the participants, if asked) as we did not want to be 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. The interviews were professionally transcribed and we use pseudonyms throughout this paper. Where we have changed details to preserve participants' identity, this is represented in square brackets. In the sections below, we identify quotes with the participants' name and the year of the interview. Identity is preserved across years and between accounts (so "Jane" is always "Jane" whether talking herself or being referred to by someone else).

## 3 OLIN CONTEXT

We conducted this work with students from Olin College of Engineering, an undergraduate institution in the United States which was founded in 1997 with an explicit mission to transform engineering education [12].

Olin 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 [10]. 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 [30]. 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. 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." [26] *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.

## 4 ON REPEAT

"Probably most stories are potentially repeatable but not necessarily repeated." [24] We interviewed our participants in 2013 and in 2017 and our first reading of the data was to look at the difference between the interviews. As with re-photographs, we expected to recognize much as the past events would not be different, the participants would still have attended the same schools and been taught by the same teachers. And some within our cohort told recognisably similar stories on both occasions. We call these *stable stories*.

Others, however, followed different patterns. A second pattern we called *compression stories*. 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." [16] We had some in the cohort that displayed this type of difference.

A third pattern we termed *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 in 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, a valuable – if frustrating – product of the method are *omitted stories*, things told in one interview but not the other.

### 4.1 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 three 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 dissimilar as she did not name chapters in her initial interview, and has 3 additional chapters in 2017. However, her chapters refer to the same periods of time, with the same beginning and ending markers.

### 4.2 Compression Stories

In our original interviews, participants spoke a lot about their formative learning experiences and high school careers, but little about their experience at Olin. We guessed that this might be because high school was still prominent in their learning lives. In 2017, then, we expected 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)

We saw 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".

### 4.3 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, we encountered 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 a significance to the participant greater than the content of the event would suggest to us as observers. We report on three here.

> 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. 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".

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, 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)

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

These stories were not more vivid than those others told, but these 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 (to us) through repetition.

## 4.4 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. (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. (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".

Our prompt encourages not only a narrative recounting (i.e. a sequenced, often chronological, report) but also a storied one. By asking participants to recount their learning life "as if it were a book" we are making available constructs such as plot and narrator. Even though we elicit our stories 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." [16] In contrast to fictional stories, the ending in a life story is usually the present time. And the narrators – our interviewees – make sense of their experience from their present point of view.

It would be easy to cast Jesse Walker's 2013 and 2017 accounts as simply inconsistent. But between the two tellings of this story, the ending has changed: the student has graduated and Olin is now an episode, not present, 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, his transition into Olin; an inconsistent account does not imply an incoherent account.

### 4.5 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. An example of this is in 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 and, as narrative researchers term it, "tellable" [15].

Although frustrating to us as researchers, 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?"

## 5 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." [25] For all our participants, the space between the interviews was one of personal change, at the minimum, out of undergraduate education, for some of them much more, starting jobs or changing countries.

Our research focus is a) *computing education at university* and b) *the place and value of university education in students' lives*, and we undertook thematic analysis, looking for those elements in the interviews, to investigate both of these. For the first question we looked only at the six people interviewed who were computing students or subsequently pursued a career in computing (this is reported in section 5.1). For the second question we included all the interviews (reported in 5.2 and 5.3).

### 5.1 Acquisition and use of disciplinary knowledge

The computing curriculum at Olin is deliberately small [7]. 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 [7]. 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.

*5.1.1 Coming to know CS.* Our participants came to computing in different ways. In their origin stories (that is, the backstory of their exposure to computing), we see 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 [2]. Ching and Vigdor identify these "catalyst people" and, in their study, found them only out-of-school, not in teachers or formal advisors [6]. Our

data 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 [28]. 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.

*5.1.2 Learning computing.* Some, although not all, of our participants learned computing in 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 [name]. 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)

We also learned about participants' 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 [3]. We saw a similar phenomenon in our 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)

Begel and Simon also identified a lack of social and teamwork skills, as well as the negotiation of what the new employees in their study feel they can ask their colleagues. They 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." [3] 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)

## 5.2 Re-positioning university education: "Olin as inevitable"

Looking at both sets of interviews, we saw a shift 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.

> 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 [22]. 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." [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

This 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" [16].

One of the central elements of the life story are several forms of coherence [11]. Habermas and Bluck identify four kinds of coherence in their work: causal coherence, temporal coherence, thematic coherence, and the cultural concept of biography (which reflects the ways in which people in different cultures tell life stories) [11]. The repositioning we identify 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.

## 5.3 Beyond university education: always be learning

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)

> 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 single 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 we find 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)

## 6 CONTRIBUTION & LIMITATIONS

This work is limited in its situation in non-traditional, elite education. However, we believe that the re-positioning of these students' undergraduate education in the wider context of their learning trajectories is applicable to graduates of more than a single institution. Re-interview as method, as in re-photography "… involves the presentation of sequential image pairs, in which the second modifies and expands our understanding of the first" [4]. Just as photographs of the "same" scene taken years apart expose different changes, our re-told narratives show events that stay the same, stories that are virtually identical, and experiences that have become differently important.

In this paper we have examined both the method of re-interviewing and what it can reveal. In terms of method we have described a preliminary classification for twice-told stories. In terms of analysis we have seen how university education is differently valued by students when they are in undergraduate study and when they are past it. For the students in this study, the content of their course was ultimately unimportant, to the point that they find 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). What they do take away is lodged in their attitude to learning and associated metacognitive skills "… 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, will not show the same quality of difference. However, the method used in this paper exposes the distinctive, and lasting, characteristics of a degree programme. As academics, we rarely see students after graduation, and then not systematically: this permits a longer view.

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