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## A pedagogy for success: two stories from STEM

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### ABSTRACT

This paper aims to debate the need to change our discussions from the pedagogy of success to pedagogy for success. In justifying the prepositional shift, we discussed our understanding of success and pedagogy using some relevant literature, followed by the five key features which formulate our pedagogy for success. These features are the web of relations with people, learning objectives established subjectively (or not), the flow from knowledge patterns and streams, the experiential texture and the self and/or situationally ascribed evaluative tone. Each of the five features exhibits no set recipe of particular proportions that a teacher, student or professional can use to become successful in STEM or a toolkit that has certain STEM-based specific skills, abilities and knowledge leading to a successful STEM life. Instead, the pedagogy for success challenges the set criteria of success, by highlighting the ideology of personalised non-hierarchical successes from a variety of sources and spaces. Practically, using the five-featured theoretical framework, we have showcased the STEM stories of Amna and Samreen from our 2021 qualitative, *entre-deux*, autobiography-styled data collection. Finally, discussing pedagogy for success using five crosscutting themes that exhibit a non-linear and long-lasting acquisition of a successful STEM life.

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Autobiography; *entre-deux*;  
pedagogy; STEM; success

## Introduction

Small prepositions make all the difference. There are several contributions in the field that discuss pedagogies *of* success, our discussion here concerns pedagogies *for* success. To highlight this distinction, we interpret pedagogies *of* success to imply successful outcomes achieved through particular pedagogical approaches, successes resulting from specific instructional practices in clearly delineated contexts. In science and mathematics education, this has been discussed in terms of classroom teaching methods that can be shown to lead to high academic scores and grades. On the other hand, we interpret pedagogies *for* success, to imply broader background conditions, wider aspirational directions, a greater range of desirable purposes and destinations – that is, many journeys rather than any single labelled destination. An analogy might be made with the adages ‘assessment of learning’ and ‘assessment for learning’. The first implies the – often summative – assessment of learning tasks already undertaken and in need of evaluation, while the second implies planning, preparation and provision as a basis for formative assessment, a platform of support for ongoing learning. This second meaning brings us much closer to the ways in which we like to work, and leads us to a pedagogy *for*, not *of*, success. As the Spanish poet Jose’ Antonio Machado

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once wrote: ‘Walker, there is no road; you make the road by walking’. Our research explores the many roads walked by our participants.

Our intentions, then, are to describe and discuss pedagogy for success by drawing on data from our several recent studies (Salehjee & Watts, 2015, 2020, 2022). Our participants in this work have all been south Asian women resident in the UK, and from across a wide age-range and backgrounds. At first sight this might seem an unusual constituency but the original study (Salehjee & Watts, 2022, 2023) took an intersectional view of women in science and our participants enabled a very rich understanding of the roles of culture and heritage in discussions of science success. Although we include here aspects of biographical and interview data based on that work, our use is illustrative rather than exhaustive: this is a position paper rather than a fully empirical account. Our data is derived and fashioned from a large number of individual conversations, STEM life-stories, and we describe our methods as ‘entre-deux forms of autobionarratives’, more of which later. First, we forge a clearer distinction between *of* and *for*.

### **Pedagogy of success**

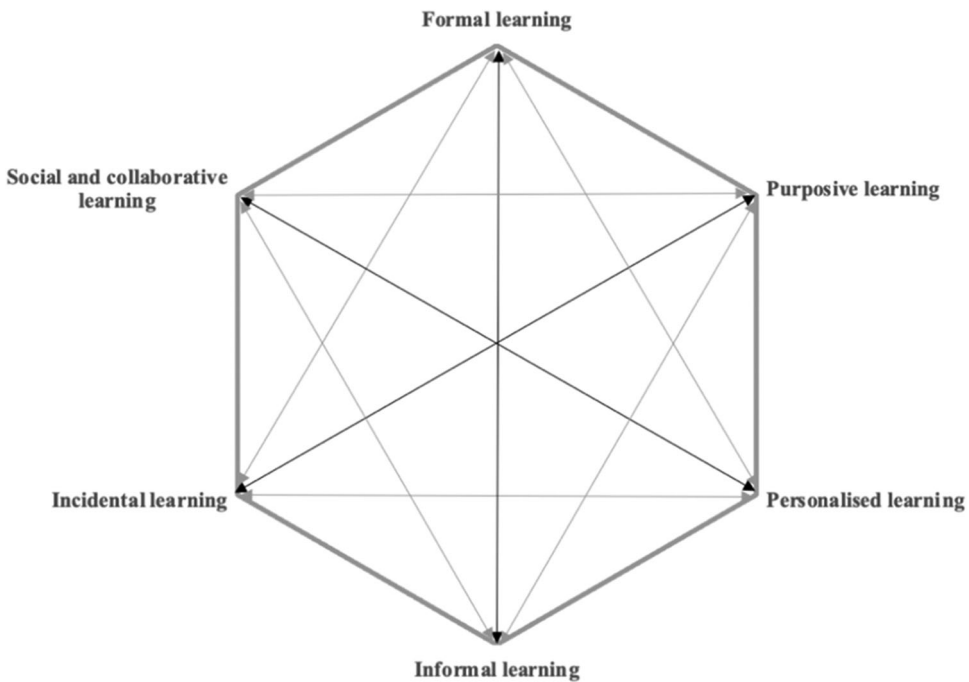
In her paper, Bowers (2000) contrasts a pedagogy of success with a ‘pedagogy of poverty’. Her laudable goal is to increase academic achievement among young adolescents in under-served urban middle schools in the U.S.A. She sees a pedagogy of poverty resulting in schoolteachers and their students being immersed in maintaining an underperforming status quo, a ‘get by’ mode that both inhibits and frustrates the principle goal of generating higher achievement in test scores. Her action was to design and employ a ‘critical set of effective instructional strategies that move students from the “pedagogy of poverty” to a “pedagogy of success”’. These instructional strategies result in a high level of student achievement on standardized tests’ (p. 237). In a similar vein, Rompelmann (2002) is concerned with effectiveness in school classrooms. She proposed three components to strengthen a pedagogy of success: (i) opportunities for student response, (ii) student feedback, and (iii) consideration for the person: all aspects of the affective domain seen as important to an ‘achievement environment’ in which students become fully engaged in learning and increasing their examination scores. Bilican et al. (2020) focus on primary-age (K2) children’s classroom science and extol the virtues of co-teaching in enhancing teacher success which, in turn, stimulates learner success. Valverde-Zavaleta et al. (2021) also argue for a pedagogy of success based on ‘didactic strategies’ to motivate learners. Their aim has been to encourage university students to manage their learning with ‘the use of ICT to avoid failure or the feeling of academic loss’ (p. 3). What is interesting in this study is the quite significant divergence of opinion as to what actually constitutes pedagogical success, differences, for example, between undergraduate and postgraduate university students. Unsurprising in our view, different people have quite different perceptions of exactly what is entailed by success.

While Southwick et al. (2017) have also been concerned with improving college completion and success rates, in their case for undergraduate Māori and Pacific students, they have undertaken this through a much broader approach both to pedagogy and success. In their work they explore (i) the creation of a safe learning environment, (ii) seeing students’ culture as an asset rather than a deficit, and (iii) providing students with access to the ‘rules of the (academic) game’. Moreover, unlike the other studies cited above, these authors concede that there is no single ‘recipe or codified manual that could possibly represent what is meant by a “pedagogy of success”’ (p. 36) as examined in their project. In their opinion, then, a universal set of effective instructional strategies simply does not – cannot – exist.

### **Success**

We have no single definition for success. Ours is a multidimensional polymorphous approach that sees success in the plural: successes. There are certainly degrees of success, but these are relative, we

have no absolute measure. Moreover, for the many participants we spoke to, the antonyms were not failure, but ‘setback’, ‘mishap’, ‘complication’ or ‘frustration’. This is not to say that all respondents were unflinchingly positive in outlook, people can look at their achievements as both small and large, can have good days and bad days, and can recognise hindrances, delays and reversals (Ryan & Deci, 2000). But they were also comfortable distinguishing between *having successes, making a success of things* and *being seen as successful*. ‘What do you count as success?’ brought forth a range of answers: success at school, success at work, success in life generally. Personal success is habitually determined on the basis of an individual’s socio-economic status, educational and professional gains etc. However, the ‘human flourishing’ ideology of living a life with contentment and happiness overpowers the acquisition of competition, position, wealth, promotion and societally recognised laurels (Pawelski, 2021). Similarly, Francis Su’s (2020) book, highlighting the stories of people flourishing in mathematics, emphasises that enthusiasm, passion, happiness and self-satisfaction towards mathematics in their lives go beyond and above the way mathematicians are portrayed in society as belonging to the elite, well-off and well-informed mathematician families, attended prestigious schools or colleges, have unlimited opportunities and so on. So, with STEM life revolving around qualifications, ‘stand-out moments’, problem solving accomplishments, a certain satisfaction with outcomes and recognition at work (Goulden et al., 2011; Howes et al., 2018; Resmini, 2016) makes educating for success complex (Salehjee & Watts, 2023). With no specific target and with multiple measures, an educational approach must establish the conditions, create the setting for group and individual achievement. An analogy might be coaching at an ‘all-comers’ swimming or walking club where some are enabled to compete in elite teams and events, while others make progress on their ‘personal best’ times or scores. A pedagogy for success looks to create the formative influences, the preconditions that support for success.



**Figure 1.** Intersecting formal and informal STEM (Source: Luo, 2022).

## Pedagogy

We begin with [Figure 1](#), adapted from the work of Luo (2022), to depict the range of educational provision and institutions in which we have interest.

The position we adopt allows us to explore established (formal) educational provision as well as that developed in many other (non-formal) areas of educational life; individual as well as group education; structured as well as serendipitous learning. We are not pinned to an institutionally based approach to curriculum or instructional design and favour education in its broadest sense – encompassing children, adolescents and adults (young and old). As Giroux (2004) says,

Pedagogy is not simply about the social construction of knowledge, values and experiences; it is also a performative practice embodied in the lived interactions among education, audience, texts and institutional formations. Pedagogy, at its best, implies that learning take place across a spectrum of social practice and settings. (Giroux, 2004, p. 61)

A second point of entry takes note of Bernstein (2000), who wrote that pedagogy:

is a sustained process whereby somebody(s) acquires new forms or develops existing forms of conduct, knowledge, practice and criteria from somebody(s) or something deemed to be an appropriate provider and evaluator. (p. 78)

There is much to be absorbed here. For example, this puts the onus on the process of acquisition – it refers to someone *acquiring ... from*, rather than ‘a provider’ *providing ... with*. That is, pedagogy is not of itself about ‘telling’ or ‘instructing’, it is not didactics, and Bernstein inverts here a common sense of pedagogy as necessarily being the ‘the art, science and craft of teaching’ (Watkins & Mortimore, 1999). This perspective is not a pedagogy of the instructional science. There is also mention of forms of conduct, of practices and criteria – which we take to include judgements, mores, morals and values. That is, education – and the role of the pedagogue – is about much more than just stipulated cognitive aims and objectives, it also includes for example personalisation, socialisation, disciplinarity, evaluation and accreditation – as well as the political, economic and cultural aspects of the educative systems being used.

We expand, too, away from science alone to include technology, engineering and mathematics in a concern for STEM more widely. As Carlucci-Gray (2022) points out, STEM is not actually an easy or uncontested construct since it can appear at times as a simple co-listing of more-or-less related disciplines, or as a multi-faceted, interdisciplinary hybrid of these. Banks and Barlex (2020) signal this as the difference between S.T.E.M. (as separate but co-existing entities) and STEM, as an integrated wholistic bank of problem-solving resources. Our use of STEM rather tends toward the pragmatic: we have drawn research participants from the broad spectrum of sciences as well as technology, engineering and mathematics. Whatever can be said of the breadth and scope of the TEM elements of that quartet, ‘science’ alone is known to be a broad church of many sciences, from astronomy to zoology and all letters of the alphabet between. This gives us an enormous number of disciplinary fields to work with.

## Pedagogy for success (Pfs)

We are interested in five particular features of Pfs and the pedagogical morphing that happens (i) with shifts in the physical environment, and (ii) the dispositions of the learners. These five features are not original, but they work here to provide the backdrop for our pedagogy for success. They focus on a series of pedagogic features and are drawn from a range of writings concerning the ‘workings’ of pedagogy – for example, Crownover and Jones (2018) write extensively about relational pedagogy, Kerry (2002) about learning objectives, Glessner and Olufemi (2019) on knowledge flow, as do Garber et al. (2019) concerning evaluative tone. These decisions are:

- (1) *The web of relations*: Our research questioned the interconnectivity of people, and what value it has in the learning of STEM issues. In each of the six learning situations in [Figure 1](#), it is

possible to explore the relationships between teachers and learners, and how these are shaped. This includes the overall ‘culture’ and ethos of the learning space and how this enables and respects the sharing of power (Cochran-Smith & Lytle, 1999). It shapes the ways, for example, in which people work and share their learning, can create a sense of both individual self-determination and of belonging (Southwick et al., 2017). Positive relationships, whether at school, university or within other learning communities are seen as the bedrock for generating an atmosphere of success. Communal activities in STEM can be an important lever in increasing STEM positivity and motivation (Diekman et al., 2015).

- (2) *The learning objectives*: in each situation in Figure 1 there will be a different focus on learners’ needs and goals, their learning objectives, their ambitions and aspirations. Decisions in this case will weigh pedagogic processes that interchange between teacher-determined objectives and learner-initiated learning (Kennedy et al., 2007). So, for example, this might provide prompts to understanding of people’s STEM lives, the nature of science identity, the multitude of STEM-related careers. Our research questions here related to who set the goals, and how were they set? Again, what counts as success?
- (3) *The flow of knowledge*: this involves the directions of the flow and exchange between teachers and learners, between learners and learners. They are decisions on when to ‘hold in’ and teach or devolve responsibility and generate collaboration with and between learners, moves from teacher-telling to exchanging with ‘more-knowledgeable others’ (Nissen, 2006). Here lie opportunities for learners’ voice, for expressions of culture, for gathering feedback and giving stories of success. These opportunities will arise differently in each of the six learning situations depicted in Figure 1. Our participants were asked the extent to which they were able to contribute as well as receive during exchanges of knowledge.
- (4) *The experiential texture*: What was the learning like for you? How well did it work out? These are sometimes questions about the setting, the organisational details, the resources and materials, the managing of learning engagement, maximising the opportunities unique to the immediate environment. It might involve moves – for example – from serious work to play learning and back again (Fenwick & Landri, 2014). Again, the formal or informal context of the situation, say, would impact upon this experiential texture.
- (5) *The evaluative tone*: evaluating self and collective effectiveness and outcomes. This, too, is shaped by the situation. So, there are commonly very clear criteria and expectations allied to evaluation in formal learning situations where accreditation is part of the situation, and this is often framed as formative and summative assessment (Sheafer, 2007). On the other hand, commendation, compliments and praise are more likely in informal contexts. Social and collaborative situations might bring approval and applause, while personalised situations are likely to deliver moments of self-satisfaction.

We use data from our study of success to illustrate these five features – after, that is, a mention of methods.

## Methods

The aim of our studies has been to explore the lived experiences of pedagogies for success. Our approach to understanding success is grounded in narrative – much can be learned about success in life from stories (Clandinin & Connelly, 2000). Narrative inquiry is grounded in the study of the particular and has the capacity to reveal the complexity of human experiences to understand how people make sense of themselves and their lives (Riessman, 2008). We describe our approach to narrative data gathering and analysis as a series of semi-formal ‘conversational autobiographical interviews’, similar to Reese et al.’s (2010) *Emerging Life Story Interviews* (ELSI). We have sought interpretative commonalities in our conversations with our participants as they narrate personal events in their social and cultural worlds. We have used probes and spontaneous questioning to

deepen our understanding. After a suitable preamble, our first question has usually been: How do you identify yourself? And, if the response is, for example, ‘*as a British Indian woman and engineer*’, then our further questions have probed her perceptions of learning science (in her case engineering) as these pertain to PFS.

In some respects, the data we use here is retrospective, the re-analysis of data drawn from a broader qualitative study (Salehjee & Watts, 2023). Samreen and Amna were both interviewed in 2021 and, inspired by Kvale and Brinkman (2009), we have examined the data with several questions in mind to gain a more subjective perspective: What stories do the participants tell? What do they experience as important for building success? In which situations do they experience success? What are the turning points related to learning to be successful? Narrative scholars highlight the importance of keeping a story intact and theorising from the case, not from the component themes across cases (Riessman, 2008), and this is how we have worked here.

Our sample inclusion criteria have been fairly broad, our definitions of STEM subjects have been reasonable inclusive. We assured the participants of full confidentiality, and they were happy with the pseudonyms we have assigned to them. They were interviewed individually, discussions lasting from around forty to seventy minutes concerning educational choices and career decisions. Some interview conversations took place ‘at a distance’ (through Zoom) or face-to-face in quiet, private areas, at times convenient to them. Our aim was to create dialogues with women who were relaxed and eager to talk about themselves, about their lives, their professional concerns, their histories, families, preoccupations about science and – of course – about success. We encouraged their explanations and meaning-making, self-questioning, observations, views, opinions, recollections and forward projections. Our aim was not just to set out markers for what constituted their science identities, the ways in which they saw themselves in relationship to STEM, but also the ways in which they constructed success.

### **Autobioracy**

The difference between biography and autobiography is the person writing the story: autobiography a first-, biography a second-person account. As Plummer (2001) maintains, autobiography is comprised of three elements, *autos* (what do I mean by the self?), *bios* (what do I mean by life?) and *graphie* (what do I presume in the act of writing?). We might adapt this in our own work as ‘autobioracy’, replacing *graphie* with *oracy* (what do I presume in the act of talking about myself?). Moreover, rather using the more literal but clumsy form, autobio-oracy, we have shortened our constructed term to autobioracy as a neater form, requiring ‘bio’ and ‘oracy’ to share the letter ‘o’. Autobioracy then is the act of talking – ‘storytelling’ – about ‘self’. There are many other questions that arise from the act of ‘storying’ one’s life: What is my life? How do we tell stories about a life? What is the link between a life lived and a life told? How does a life’s telling connect to my culture and its – and my – history? How does the telling of my life connect to someone else’s telling of my life? Are all lives to be told equally or are some better to tell than others? We did not ask our participants to write their stories, instead we sought the spontaneity in what is said and discussed. Oral narrative is a social act and stories encapsulate experiences that people can recount to others. In contrast, story writing is deliberate and measured, typically done alone, is less audience specific and subject to editing and ‘smoothing’ of intentions and actions. We see ‘autobioracy’, then, to be enormously useful in shedding light not only on the shifts and movements in individual educational and professional lives, but also on the importance of culture and heritage in their lives, in tracing these orientations to their source and understanding how they have – and are being – developed. To this extent, we see our participants as ‘transformative intellectuals’ (Giroux, 1988) who shape their own lives whilst at the same time as finding meaning in the greater swell of things.

### **An 'entre-deux' approach**

We can, though, separate first-person from 'other person' perspectives. First-person accounts are discrete perspectives and descriptions of what that individual is experiencing or is attempting to do moment by moment. Other-person accounts are different, these are the perspectives of observers who label and portray the events and occurrences as they happen not to themselves but to other people. In this paper we adopt a position somewhere in between, in the 'entre-deux' as phenomenologists would have it. This is the hybrid space between first-person and other-person accounts. So, all of the stories, the autobiographies, we have been given are first-person reports of experience, of our participant women's lived experiences. However, in relaying these to the reader, we have necessarily trimmed and edited, 'grammaticised' and sometimes abridged what the women were saying. For example, the interviewer's voice was removed, quoted speech cleaned up, and messy spoken language transformed to make it easily readable. That is, we have 'storied' their stories, we have interpreted what we think the women were saying and have presented this in the form of a story. We ourselves are neither inside the story nor are we outside of it, hence the *entre-deux*. As might be expected, we have tried strenuously to remain as faithful as possible to the intentions we can divine in the words and behind them, though in using the caveat 'as far as possible', we recognise that we are active players in the process and are inevitably interpreting their stories through our own 'lensed' perspectives. Whenever the possibility has arisen, or has been feasible for us to organise, we have checked our versions of the stories with our participants, to align with what the women themselves were saying. We have then amended our versions where necessary to meet their needs.

### **Two cases, two STEM stories**

Meet Samreen and Amna, both women happy with the pseudonyms they agreed for themselves.

*Samreen* is twenty-seven and a graduate engineer. Her parents are second generation Indian Sikh, her father working for a print factory, her mother in an insurance office. She is the second of six children. She was a serious child at school, worked hard and played under-sixteen hockey to regional standard. Straight from university she worked for an aeronautical company at Heathrow Airport in west London although she is currently employed as a production engineer for a major food manufacturer in the Midlands of the UK. The factory makes several household brands of biscuits. Some of her time is spent ensuring the correct temperature profiles of the enormous ovens as the biscuits move through, double cooked as in the origin of the word *bi-scuit* (twice cooked), giving the confectionary its essential brittle 'snap'. The company uses a 'learning set' approach to its engineering problems where small teams are brought together from different parts of the company as circumstances demand. They are then disbanded once the task is complete. This means that at any one time she might be working closely, she says, with other engineers, cooks, managers, technicians, packers, fork-lift truck drivers and office staff, as the particular problem requires.

Samreen enjoys this form of collaborative working, the environment it creates and the way the company operates to engage and motivate its employees. She meets and works with new people across the company and values her own role in this. She has a growing appreciation of the many facets of the manufacturing process and sees herself as being successful in what she does. She is also an active environmental campaigner in her out-of-work time, concerned in particular with air quality in the neighbourhood where she lives. She spends time at a local primary school taking air quality measurements in a project alongside teachers and pupils. She no longer plays hockey but has joined a tennis club.

Samreen's story illustrates many of the aspects to be seen in Luo's hexagon in [Figure 1](#). While she is no longer part of a formal educational institution there is certainly an 'educational drive' within the organisation of the company in which she works, a drive that pushes her both to 'learn on the job' and to take additional university qualifications. While some of this learning is directed by her



line managers, she also has freedom for self-direction and self-expression, she must act in her own capacity as an engineer as well as collaborate in a team of broad and mixed expertise. We see Samreen's life as a useful example in illustrating some of the features of a pedagogy for success (Table 1).

Samreen's account here also illuminates different forms and different degrees of success. She provides good evidence that the overall approach adopted by the company creates the environment and fosters participation, achievement and reward – and Samreen takes from this what she can.

*Amna* is in her forties and is a stroke consultant. She was born in Lahore, Pakistan and received a Bachelor of Medicine and Surgery (MBBS) from Pakistan. She was always seen as a doctor, even during her primary schooling because her family in her community were (and are) 'recognised as a family of doctors. When I was young, people used to say you are very intelligent, so you will – definitely – become a doctor, like your father'. In addition, Amna's father worked as an army doctor and as a child she moved from place to place to serve the army and, in turn, the public. So, her ambition to help people became deeply rooted in her childhood. Some family members (not

**Table 1.** Samreen's account.

	Comments
Relational web	'I grew up in a big Indian family – everyone has an opinion. Brothers, aunties, cousins, everyone. There was never any chance of me NOT knowing what I was going to do, what career I would have, I was pushed to answer almost every day. There was no 'Oh I don't know ...'. No, no doubt at all, I was always going to be doctor or teacher. I chose to be an engineer and they're OK with that'. 'I really enjoy working in the company. In fact, they paid for me to do the MSc, so I was very lucky, I had a very supportive team. They want all of us to get more qualifications, I think it gives the company extra kudos'. 'We work together in small project groups. We have very specific tasks and the groups are never the same because the tasks are always different and need different skills. We had to solve the problem of the ink on the plastic packaging coming off too easily and contaminating the containers. It was a chemistry problem. Even so, we had someone from marketing in the team and she was really a great success!'
Objectives	'Half and half, really. Sometimes the goals are set for me, and I'm OK with that, I can usually buy in to what is needed. But equally often I set my own goals, get to go to where I want to go, suggest my own projects'. 'I don't live at home anymore; I have my own place. I miss the noise of the family, though, people telling me what to do and me telling them where to get off! I talk to my mum on the phone most days and so I am never short of advice on what to do next'. 'We have performance review meetings, and I am always asked to say what I want to get done over the next year or so. I like that, it keeps me in the job. It keeps me focused. I like to set and meet my targets'. 'I am part of a local campaign to manage the traffic and the air quality by our local school. My best friend is a teacher there. And we are making headway with the local officials. I am really proud of that!'
Knowledge flow	'Even in the MSc we were expected to make contributions, either from the kind of engineering we did, or in the way the company was managed, and so on'. 'I know my dissertation supervisor was learning with me as we went along with the study I was doing. He said as much himself!' 'The workgroups come together to solve a particular problem, say a production-line issue. We all have different expertise and we really do share our knowledge. I love that, one of the real successes of the system, I learn so much from the others, and I like to think they learn from me'. 'Others in the company can be a bit daunted by me being a graduate engineer with a masters degree, you know, they don't have traditional qualifications and so they sometimes think I should have all the answers. It's soon clear I don't! Once we get past some of the awkwardness and defensiveness, once they see I am quite human really [laughs], we get going quickly and, sure enough, they all have important contributions to make'. 'We are not afraid, either, to bring in outside help. The company is good like that. It might be a software problem and we'd be all at sea with that. The thing is, we'd have worked together to narrow down the issues and then bring in specialist help, so we all gain'.
Experiential texture	'No two days in the company are the same. I never quite know what lies ahead each day I go in. Oh, sure, we have some medium and long-term tasks to tackle as well. For example, we outsource some of the production tasks and our management team wanted us to bring that in-house, so that we have more quality control, and we could harness the expertise to develop new ideas. We were tasked with managing that. I loved it, it was great fun'.
Evaluative tone	'Yes, we are evaluated. Of course. But the best evaluation is whether our solutions work or not. We are judged on results'. 'I think we know when things are not going well, when progress gets stuck, for example. We are usually fairly honest with each other, we say 'It's just not working, is it?' I think we are harsher on ourselves than our managers are, I think we'd rather show up our own mistakes than have them shown up for us'.

her parents) gave suggestions that Amna become a dentist rather than a doctor largely because it is a 'shorter route', 'easier life' and gives a better home and work-life balance but, Amna, never wanted an easy, i.e. 'boring life'. Straight after MBBS she was married to a Pakistani doctor. They immigrated to England soon after when her husband was offered a post with the National Health Service, where Amna delayed her practice for five years to raise her young family.

Like Samreen, Amna's story illustrates many of the features illustrated in Figure 1. Below we highlight Amna's account presenting the inner drive and self-willingness to proceed with the purposive formal and personalised informal learning despite some family and immigrant challenges (Table 2).

Like Samreen, Amna's route through the education system seem a mix of formal, institutional, qualifications-based provision alongside informal, on-the-job learning with colleagues, and self-

**Table 2.** Amna's account.

	Comments
Relational web	'I am from a family of doctors, so I always knew and aspired to become a doctor ... When I was applying to a medical school at that, time the merits needed for dental school were a little less than medical school, and also the life of a dentist has a better work-life balance. Some people in the family said 'Okay, maybe you should try becoming a dentist rather than a doctor, because then that's a shorter route and easy life afterwards as compared to doctors'. But I'm sort of a person who, despite of going for an easy life – I think that you should do what you really like or what you enjoy – and I thought 'Oh that's so boring, to look into just at the mouth of the person' and the idea of it felt very uncomfortable ...' 'When I was not working, I never used to say to people that I was a doctor, even if they asked me, because I used to feel ashamed saying that I'm a doctor at the time. Like when my son was born, I used to go to GPs for vaccinations and stuff, and there was a Bengali doctor there and once I asked him a few medical-style questions related to my son's vaccination, he asked me, 'Are you a doctor?', I said in a very embarrassing manner, 'Yes I am'. And he said why are you saying that so reluctantly? I told him because I don't practice. He said Oh, 'So what's wrong with that?' He sees many Pakistani women who are doctors, not working and still very happy; 'Why do you feel like that?' I said 'Yes – but I'm not happy'. Interestingly, one day, I went to him, and after a year or so, when I started working, he said, 'Have you started working? It seems you have'. So I was like, 'Oh, how did you find that out?' and he said, 'Because you look very happy'.
Objectives	'Obviously, I took permission from my husband [to continue with medicine after the children]. Still, obviously, there wasn't much keenness from the family for me to work, and as a south Asian woman, it's expected of me [therefore] to take care of all the household and the kids. I did flexible training so that household work was not compromised. But I didn't get many bleeps in the first year, and I didn't like it. People used to hate the bleeps, and I actually wanted them – because I had in my head that I had not worked for the last five years, and I had to compete with these newly graduated junior doctors. So, I always thought that I had to compete with them to make sure that I was doing more than what was required of me to keep on getting the training post, and thank God, I always got the post'.
Knowledge flow	'I can't generally concentrate on memory techniques to get good marks, So I always prioritise having a good, a full, understanding of concepts or the processes. And once I've understood, I'll just say I've learned it [and] that's fine'. 'I will never do rote learning of, like, medical terms. They were the worst thing for me because then you have to stick to the wording, so that was the most difficult thing for me to do'. '... and I always look at the real-life side of things, working for the best institution in the world, the NHS, where I have learnt, and continue learning, a lot everyday day from so many different doctors and nurses, ... My opportunities to share knowledge and practice are never limited'.
Experiential texture	'I don't always read literature books, whereas my husband is quite into reading and he encourages me to read his books. I prefer to read other books, like religion or medicine – nowadays, everything is online. I just think medicine is so vast that I don't get time to read outside of medicine much. I don't think that's a problem since I enjoy it, and I think it's a blessing that I enjoy reading medical stuff [outside of my specialism] as well. I think yeah, it is difficult sometimes being a woman. It's difficult to persevere, and I think you have to be strong. Although things can affect you, nevertheless I feel happy. I feel happy about whatever I've achieved and learned over time'.
Evaluative tone	'... when I did my first-year appraisal, the training programme director said to me, oh, you've done quite a lot in the first year. And I said no, I hadn't done much. She said, 'no, you've done these, and you have done the optional bits as well', but I was like yeah, I have done that. Still, there was another option I hadn't done, and she said, 'no, no, no, you have done quite a lot already', so anyway, I didn't say anything further. Still, I didn't take that; I've done a lot. Next, at [the point of] of ARCP [Annual Review of Competence Progression] ... they again said, 'Oh you've done quite a lot, very good' ... [and on] competency-based achievements I achieved everything in four years [rather than five years]'.

directed learning through her own reading. Unlike Samreen, she is also a full-time mother and home carer, and her pride in her own successes is tempered by the work pressures she feels and the home responsibilities she carries.

## Discussion

Acquiring high self-esteem and feelings of success are not accomplished in a linear fashion, but rather occur through long-lasting processes. We have identified five crosscutting themes in our analysis of what the women in our studies have been saying. These are exemplified in Amna and Samreen's stories as they describe the relationships, goals, ambitions and 'states of being' that are indicative of their successes. These five are:

- (1) Success is finding contentment and happiness. Amna and Samreen shared with us various happy moments of their STEM lives. There were some decisions which were unexpected and some difficult to make within homelife or the workplace. However, overall, both have relied on strength of character to overcome difficulties and develop their self-satisfying and lasting contentment by living and dealing with the challenges as they happen, there seems to be no long-lasting enmity about 'their lot' in life.
- (2) Success is prospering against the tide. Both STEM stories exhibit the self-belief needed to go against both societal norms and stereotypical families' perspectives. They both appear to make their own stand in respect of their STEM studies and career decisions as these intersect with societally ascribed markers of gender, culture and heritage. Nevertheless, they kept 'going against the tide', even sometimes above the tide, to achieve success in their STEM working lives and occasionally balancing these with the (un)supportive attitudes of people and society around them.
- (3) Success is having access to significant others. Both Amna and Samreen mentioned family and colleagues who were less than appreciative of their STEM working lives. At the same time, they talked about access to arenas for coping and achievements via discussions with great teachers, mentors and colleagues who played significant roles in their STEM journeys. Their autobiographic accounts exhibit a realisation that being surrounded by significant others who appreciate and support their progression in STEM is a success for them.
- (4) Success is being altruistic. In addition to being appreciated and supported by others, they succeed by supporting their team members, colleagues and family. Moreover, they support people's learning process at their workplaces and, where possible, the general public through their STEM expertise. They worked in professional and volunteer capacities, in fact, they feel strength in their self-success journey by helping others to succeed.
- (5) Success is having an appetite for continual learning. Learning is an everyday and never-ending vector leading to success in STEM for Amna and Samreen. The fascinating aspect of their stories is that they are not shy of accounting for exactly what they gain from other STEM professionals/non-professionals and from books outside their own specialism; instead, they put extra effort in to achieve learning from outside their personal realms of expertise.

There is no one meaning of success (Bostock, 2014, p. 7), and it comes from within through self-contentment, internal drive service for others and continuous informal learning (Gomez, 2020; Gotian, 2022; Goy et al., 2018). Most certainly, pedagogy plays a vital role in developing successes in STEM education and career choice. However, pedagogy is not limited to popular formal and informal teaching and learning strategies, there is no single instructional 'straight line' between teacher and taught. Rather, as Biesta (2014) points out, pedagogy is much broader than that. For our participants, a pedagogy for success involves a personal drive to achieve happiness and long-lasting contentment, directed at the goal of living a 'good STEM life'. This is supported by strong and constructive relationship built with others. This personal drive and relationship building strengthens

individual determination to overcome stereotypical norms, cultures and customs. In our two cases, the ‘flow of knowledge’ as learners and teachers work are not solely unidirectional and uni-sourced from within formal educational spaces, and one key to success is the willingness to tackle STEM study from whichever sources the individual sees as appropriate.

In this position paper we have proposed an alternate way to discuss diverse routes to achievement and success in STEM education. In presenting a position, we are several steps removed from immediate and direct educational practice. There is much for educators to consider in their design of any pedagogic experiences. Given these observations, though, we do suggest two broad ways forward.

Our first is a deep belief that insights and understandings produced by research of the sort we report here can provide important inputs to educational thinking. Establishing a pedagogy for success requires STEM learning to function within a relational web that fosters personal freedom and agency, the opportunity to support self and others and an ongoing self-evaluative nature. This poses something of a challenge: different pedagogic approaches will yield different results, will foster different definitions of successes. Rennie et al.’s (2019) useful consideration of adult and lifelong learning in STEM does highlight ways in which educators can support adult learners beyond the years of formal schooling. They offer a research-based exploration of adults’ self-directed learning and provide some basic tools to support adults’ learning experiences in a wide range of environments while being inclusive of all educational backgrounds.

Our second can be stated relatively easily, we must not expect any universal answer for how to generate success in STEM. Rather, any suggestions to be made will be specific to populations, subject matters and pockets of time. In her book *Plans and Situated Actions* (1987), Lucy Suchman likened educational practices to the canoeing of a rapids. We see her central point being that human endeavours and activities are not, in general, driven by major overarching plans or other grand ambitions. While this may be the case for a few, we see from our participants that, as with the canoeist, they might embark on an expedition, but their immediate actions emerge through multiple interactions with turbulence in the world. While we cannot tame the rapids, we can support the canoeists in preparation for their endeavours.

## Ethics declaration

Full ethical approval in collecting the interview data was given by the University of Strathclyde Education Ethics Committee in the year 2020 and 2021. We confirm all interviewed subjects have provided appropriate informed consent.

## Disclosure statement

No potential conflict of interest was reported by the author(s). All data supporting this study are provided in the ‘two cases, two STEM stories’ section of this paper.

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## References

- Banks, F., & Barlex, D. (2020). *Teaching STEM in the secondary school: Helping teachers meet the challenge*. Routledge.
- Bernstein, B. (2000). *Pedagogy, symbolic control, and identity: Theory, research, critique (Vol. 5)*. Rowman & Littlefield Publishers, Inc.
- Biesta, G. (2014). *The beautiful risk of education*. Routledge.

- Bilican, K., Akerson, V., & Nargund, V. (2020). Learning by teaching: A case study of co-teaching to enhance nature of science pedagogy, successes, and challenges. *International Journal of Science and Mathematics Education*, 19(5), 957–976. <https://doi.org/10.1007/s10763-020-10094-6>
- Bostock, J. (2014). *The meaning of success*. Cambridge University Press.
- Bowers, R. S. (2000). A pedagogy of success: Meeting the challenges of urban middle schools. *The Clearing House*, 73(4), 235–238. <https://doi.org/10.1080/00098650009600960>
- Carlucci-Gray, L. (2022). The STEM, STEAM, STEAME debate. In J. Dillon, & D. M. Watts (Eds.), *Debates in science education*, (pp. 13–26). Routledge.
- Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. Jossey-Bass.
- Cochran-Smith, M., & Lytle, S. L. (1999). Chapter 8: Relationships of knowledge and practice: Teacher learning in communities. *Review of Research in Education*, 24(1), 249–305. <https://doi.org/10.3102/0091732X024001249>
- Crownover, A., & Jones, J. R. (2018). A relational pedagogy: A call for teacher educators to rethink how teacher candidates are trained to combat bullying. *Journal of Thought*, 52(1-2), 17–28.
- Diekman, A. B., Weisgram, E. S., & Belanger, A. L. (2015). New routes to recruiting and retaining women in STEM: Policy implications of a communal goal congruity perspective. *Social Issues and Policy Review*, 9(1), 52–88. <https://doi.org/10.1111/sipr.12010>
- Fenwick, T., & Landri, P. (Eds.). (2014). *Materialities, textures and pedagogies*. Routledge.
- Garber, J., Goodman, S. H., Brunwasser, S. M., Frankel, S. A., & Herrington, C. G. (2019). The effect of content and tone of maternal evaluative feedback on self-cognitions and affect in young children. *Journal of Experimental Child Psychology*, 182, 151–165. <https://doi.org/10.1016/j.jecp.2019.01.017>
- Giroux, H. A. (1988). *Teachers as intellectuals*. Bergin & Garvey Publishers.
- Giroux, H. A. (2004). Cultural studies, public pedagogy, and the responsibility of intellectuals. *Communication and Critical/Cultural Studies*, 1(1), 59–79. <https://doi.org/10.1080/1479142042000180926>
- Glessner, M., & Olufemi, D. (2019). Pedagogy of flow. In M. Peters (Ed.), *Encyclopedia of teacher education*. Springer. [https://doi.org/10.1007/978-981-13-1179-6\\_295-1](https://doi.org/10.1007/978-981-13-1179-6_295-1)
- Gomez, R. (2020). Success is being an example: Trajectories and notions of success among Latinx faculty, staff, and students in academia. *Journal of Latinos and Education*, 19(3), 258–276. <https://doi.org/10.1080/15348431.2018.1507909>
- Gotian, R. (2022). *The success factor: Developing the mindset and skillset for peak business performance*. Kogan Page Publishers.
- Goulden, M., Mason, M. A., & Frasch, K. (2011). Keeping women in the science pipeline. *The Annals of the American Academy of Political and Social Science*, 638(1), 141–162. <https://doi.org/10.1177/0002716211416925>
- Goy, S. C., Wong, Y. L., Low, W. Y., Noor, S. N. M., Fazli-Khalaf, Z., Onyeneho, N., & GinikaUzoigwe, A. (2018). Swimming against the tide in STEM education and gender equality: A problem of recruitment or retention in Malaysia. *Studies in Higher Education*, 43(11), 1793–1809. <https://doi.org/10.1080/03075079.2016.1277383>
- Howes, S. S., Henning, J., Mills, M. J., & Huffman, A. H. (2018). Yes Virginia, there is a gender disparity problem – and it goes beyond STEM. *Industrial and Organizational Psychology*, 11(2), 318–323. <https://doi.org/10.1017/iop.2018.22>
- Kennedy, D., Hyland, A., & Ryan, N. (2007). *Writing and using learning outcomes. A practical guide*, Quality Promotion Unit. University College Cork. [http://sss.dcu.ie/afi/docs/bologna/writing\\_and\\_using\\_learning\\_outcomes.pdf](http://sss.dcu.ie/afi/docs/bologna/writing_and_using_learning_outcomes.pdf)
- Kerry, T. (2002). *Learning objectives, task-setting and differentiation*. *Mastering teaching skills series [Rev. ed.]*. Nelson Thornes Ltd.
- Kvale, S., & Brinkman, S. (2009). Interview quality. In *Interviews: Learning the craft of qualitative research interviewing* (pp. 161–175). SAGE.
- Luo, Y. (2022). *An investigation of the experience of university students and teachers with language learning and teaching mediated by mobile technologies* [Unpublished PhD Thesis. Brunel University London].
- Nissen, M. E. (2006). *Harnessing knowledge dynamics: Principled organizational knowing & learning* (pp. 1–278). IGI Global.
- Pawelski, J. O. (2021). The positive humanities: Culture and human flourishing. *The Oxford Handbook of the Positive Humanities*, 17.
- Plummer, K. (2001). *Documents of life 2: An invitation to a critical humanism*. Sage.
- Reese, E., Yan, C., Jack, F., & Hayne, H. (2010). Emerging identities: Narrative and self from early childhood to early adolescence. In K. C. McLean, & M. Pasupathi (Eds.), *Narrative development in adolescence* (pp. 23–43). Springer.
- Rennie, L. J., Stockmayer, S., & Gilbert, J. K. (2019). *Supporting self-directed learning in science and technology beyond the school years* (p. 225). Taylor & Francis.
- Resmini, M. (2016). The ‘Leaky Pipeline’. *Chemistry – A European Journal*, 22(11), 3533–3534. <https://doi.org/10.1002/chem.201600292>
- Riessman, C. K. (2008). *Narrative methods for the human sciences*. Sage.
- Rompelmann, L. (2002). *Affective teaching*. University Press of America.

- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Salehjee, S., & Watts, D. M. (2022). Intersectionality as personal: The science identity of two young immigrant Muslim women. *International Journal of Science Education*, 44(6), 921–938. <https://doi.org/10.1080/09500693.2022.2059119>
- Salehjee, S., & Watts, D. M. (2023). *Learning to succeed in science: Stories of south Asian women in Britain*. Bloomsbury Publishing.
- Salehjee, S., & Watts, M. (2015). Science lives: School choices and ‘natural tendencies’. *International Journal of Science Education*, 37(4), 727–743. <https://doi.org/10.1080/09500693.2015.1013075>
- Salehjee, S., & Watts, M. (2020). *Becoming scientific: Developing science across the life-course*. Cambridge Scholars Publishing.
- Sheafer, T. (2007). How to evaluate it: The role of story-evaluative tone in agenda setting and priming. *Journal of Communication*, 57(1), 21–39.
- Southwick, M., Scott, W., Mitaera, J., Nimarota, T., & Falepau, L. (2017). *Articulating a pedagogy of success for Pacific students in tertiary education*. Ako Aotearoa, The National Centre for Tertiary Teaching Excellence.
- Su, F. (2020). *Mathematics for human flourishing*. Yale University Press.
- Suchman, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge University Press.
- Valverde-Zavaleta, S. A., Rubio, M. R. H., & Sánchez, R. A. E. (2021). *Pedagogy of success: Perception in undergraduate and postgraduate students at a Peruvian university*.
- Watkins, C., & Mortimore, P. (1999). Pedagogy: what do we know? In P. Mortimore (Ed.), *Understanding pedagogy and its impact on learning* (pp. 1–20). Paul Chapman.