

The formation of Science, Technology, Engineering and Mathematics Teacher Identities: Pre-service teacher's perceptions

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The next 60 minutes...

Context

STEM Education

The research question

Literature

Methodology, methods, research design

Analysis

Outcomes

Personal reflections

Conclusion, implications for policy and practice

Questions

Personal Motivation

My interest in STEM education, my concerns in relation to the recruitment and the retention of specialist STEM teachers.

The supply of highly qualified scientists, technologists, engineers and mathematicians is perceived globally as being vital in securing economic prosperity, but pupils are being 'switched off'.

Improved STEM education is presented as a way forward. The supply of teachers is perceived as integral to achieving this vision.

My motivation was to gain an understanding of how pre-service STEM teachers experiences (their experience related beliefs) shape approaches to their own learning.

STEM in context: A brief background

STEM as an acronym.

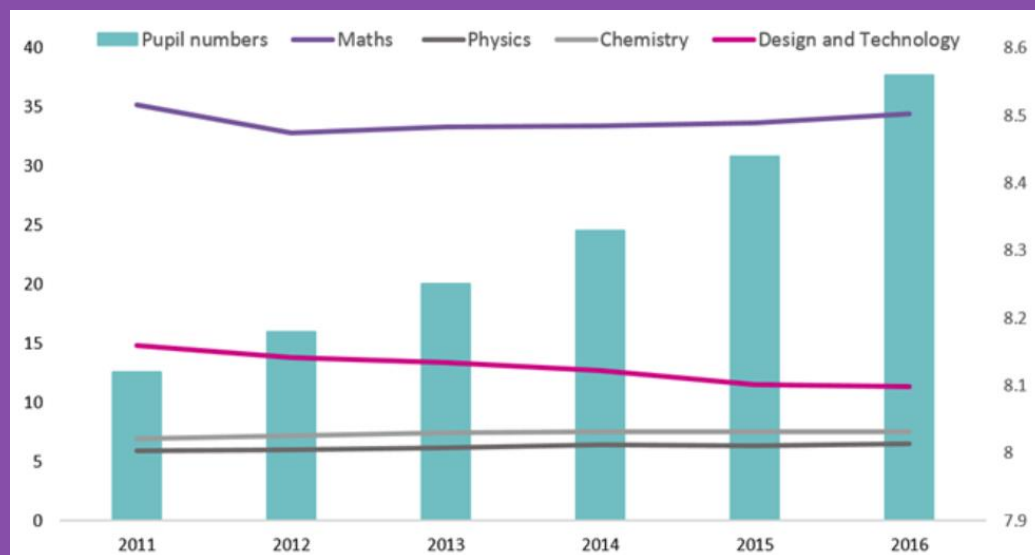
There is a global perception the supply of highly qualified scientists, technologists, engineers, and mathematicians is vital in securing the future of a nation's increasing economic productivity, prosperity, security and social well-being (Roberts, 2002; Obama, 2013; Li, 2014; Marginson *et al.* 2013).

Hence 'STEM' is the key to securing a nation's long-term economic viability (Kelly, 2012; Bruce-Davis *et al.* 2014; Tight, 2012).

Concurrent to this are reports of students' declining interest in the study of STEM (Perry & Irwin, 2015), with young people becoming increasingly disengaged with study beyond compulsory schooling (Bell, 2016).

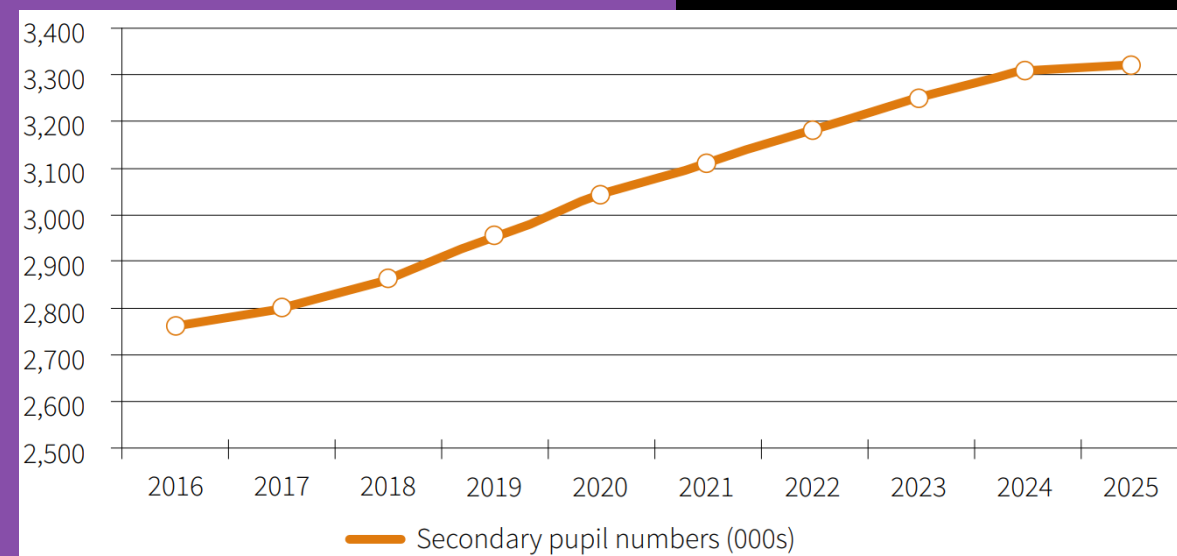
Addressing STEM through teacher supply

‘Some blame teachers for the decline in the uptake of STEM subjects’
(Busby, 2016)



Source:

Teacher numbers in STEM subjects have remained stagnant whilst pupil numbers continue to grow. Source: DfE, 2016 in EEF, Bharkhada (2017).



Source:

Projected growth in secondary school population between 2016 and 2025. Source: Department for Education SFR25/2016, National pupil projections – future trends in pupil numbers: July 2016 (Baker, 2016).

The Research Question

What influence do personal histories have in shaping pre-service teachers' professional identity?

Specifically I sought to investigate:

- how an individual assigns meaning to an experience
- how that experience informs the development of their identity and supports the emergence of self-efficacy
- how external structures (context) influences identity
- what barriers restrict learning and development

What influence do the meanings assigned to previous learning experience, including personal perceptions relating to subject knowledge, have on the formation STEM pre-service teacher professional identity?

The Literature

The review began with an exploration of identity

I kept the focus closely aligned to the socially constructed development of teacher identity. Papers falling outside of this field were not reviewed in detail.

The review led to an examination of emotion, efficacy and self-regulated learning. This in turn led to the investigation of new areas such as attrition.

I examined approaches to learning and teaching from the perspective of both the student and the teacher.

I explored STEM subjects from the perspective of pedagogical approaches and disciplinary differences.

The Literature

Defining Identity within the context of this study

Identity: Becoming a teacher

Identity: Defining emotion

Identity: Emotion and children

Identity: Attrition

“A major hurdle in gaining an understanding of identity is resolving a definition of it”

Beauchamp and Thomas, 2009:176.

“An intricate and tangled web of influences... rooted in personal and professional life experiences”

Bukor, 2015:323

- The stories people tell themselves about their lives (Sfard & Prusak, 2005).
- How people perceive themselves, how society perceives them (Gross & Hochberg, 2014).
- A form of self-understanding (Kelchtermans, 2005).
- Multi-faceted, emerges from who one considers oneself to be, and who one would like to become (Beijaard *et al.*, 2004).
- Shaping and reshaping, fluid and organic, socially constructed, changing constantly as new meanings are made (Nghia, 2017; Körkkö *et al.*, 2016).
- The difficulties of the dichotomous role of exhibiting expertise as a teacher (Volkmann & Anderson, 1998; Beijaard *et al.* 2004; Coward *et al.*, 2015).

The Literature

Efficacy, efficacy and self-regulation, efficacy and pedagogy

Learning to teach: Models of teacher development

Learners approaches to learning, teacher approaches to teaching

Teaching as Conceptual Change (a student-focused approach)

Teaching as Information Transmission (a Teacher-Focused approach)

Within the context of teacher education self-efficacy has been defined as “*the extent to which the teacher believes he or she has the capacity to affect student’s performance*”

Berman *et al.* 1977:137

Teachers’ Standards’ and disciplinary knowledge

Contextualising STEM within the English National Curriculum

Methodology

Presentation of self: perceptions and objectivity

The starting point originated as a direct result of my personal involvement and experience of STEM education. From the outset I was acutely aware of the potential to interpret data that echoed my own preconceived perceptions.

Ontology

Reality is socially constructed, with meanings constructed from our engagement with the world around us.

Multiple perspectives of a single event.

Different people interpret the same instance of social phenomena in diverse ways (Berger & Luckman, 1967; Lincoln & Guba, 1985).

There is no single external reality or truth.

I also believe that learning is an active, not passive, process.

A process where through reflection, pre-service teachers make sense of their experience, which leads them to create and construct their own new knowledge.

Research Design

Symbolic interactionism

A theoretical perspective that refers to the belief that people interpret their social world through their interaction with it (Bryman, 2015). Emphasis on the meaning that people attach to an experience that influences behaviour.

Constructivist grounded theory

Is ideal for uncovering meanings individuals' make about social situations / about the environments in which they operate (Charmaz, 2008; Aldiabat & Le Navenec, 2011). Hence aligns with my methodological choice to explore the symbolic interpretations of peoples' behaviour and my ontological position of multiple realities.

Research Design

Theoretical sensitivity

'What is really going on here?' the process of taking a step back from the data, stopping and looking at the data with fresh eyes.

Abductive methodology

Developing the strongest hypothesis, testing empirical findings against new, emergent data and making links to understand and to explain *'what is going on'*. Abduction as a *'creative leap'*, the process of putting things together in new ways (Peirce in Anderson, 2013:17).

The notion of reflexivity

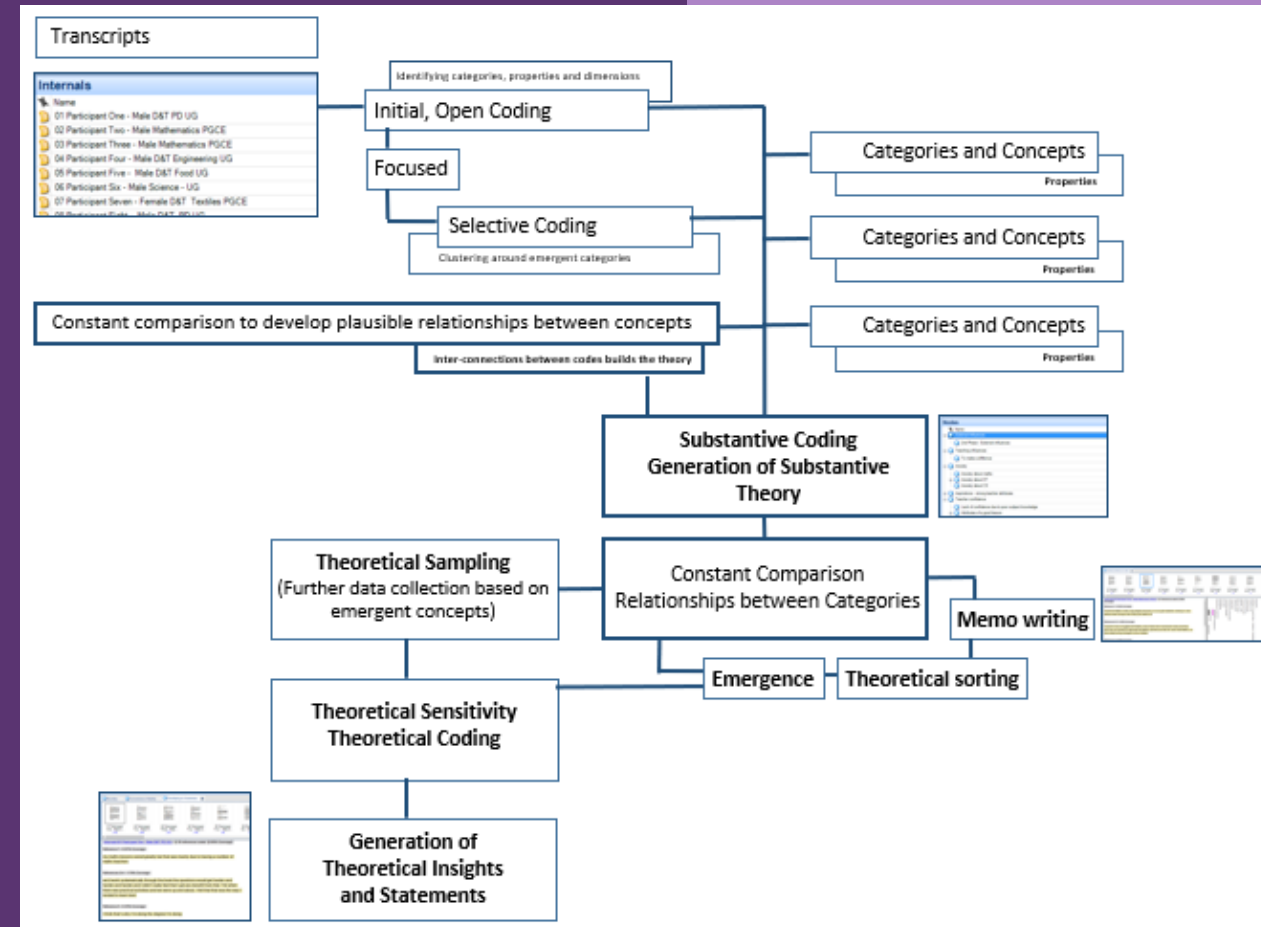
Charmaz (2014) describes how theoretical concepts are constructed, rather than being discovered, taking account of the reflexive and biographical stance of the researcher. Knowledge constructed between the researcher, and those being researched.

Research Design

Memo-writing, diagrammatic memos, and integrative diagrams

Glaser (1998): memo writing is a pivotal intermediate step between the data collection and writing the drafts of papers.

Strauss (1987): integrative diagrams, or diagrammatic memos, are useful tools that can be used to inspect emergent theories as they arise.



Visualization interpretation of the research design

Research Sample

Within grounded theory data is collected and analysed concurrently and to gain access to 'good data' within qualitative inquiry.

Morse (2007) highlights the necessity to locate 'excellent' participants in order to obtain excellent data and that sampling techniques must be targeted and efficient (Morse, 2007:227).

Online Survey						
Subject	Male UG	Male PGCE	Female UG	Female PGCE	Did not specify route	Did not specify gender
Computer Science	0	0	0	0	0	0
Design and Technology	2 (N. Ireland) 1 (NZ) 2 (Sweden/ Finland) 5 (England & Wales)	1 (Malta)	1 (N. Ireland) 7 (England & Wales)	1 (Europe) 2 (England & Wales)		
Mathematics	4 (England & Wales)	0	1 (England and Wales)	9 (England and Wales)	0	0
Science	2 (England & Wales)	1 (Europe)	1 (England & Wales)	1 (NZ) 2 (Europe) 3 (England & Wales)	1 (NZ)	1 (PGCE England & Wales)
Technology and Engineering Education	3 (USA)	0	0	0	0	0
Engineering	0	1 (Europe)	0	0	0	0
STEM	0	0	0	1 (NZ)		
Totals	19	3	10	19	1	1

Table Key	
UG	Undergraduate
PGCE*	Post Graduate Certificate of Education
	* Postgraduate study includes those following School Direct ITE training routes

Research Phase	Sampling Technique	Number of Participants
Online pilot survey	Email	53
First phase interviews	Convenience moving to purposeful	20
Second phase interviews	Purposeful moving to theoretical	10

Participant	Male	Female	Age	STEM Discipline	Training Route	Research Phase			
						First phase interviews	Second phase interviews	Focus Group	Validation Interviews
1 ¹ UG	♂		22	Design and Technology	UG	✓			
1 ² PGCE	♂		36	Mathematics	PGCE (SD)	✓			
1 ³ PGCE	♂		25	Mathematics	PGCE		✓		
1 ⁴ UG	♂		21	Design and Technology	UG	✓			
1 ⁵ UG	♂		29	Design and Technology	UG	✓			
1 ⁶ UG	♂		24	Science	UG		✓		
1 ⁷ UG		♀	48	Design and Technology	UG		✓		
1 ⁸ UG	♂		36	Design and Technology	UG	✓			
1 ⁹ PGCE	♂		31	Science	PGCE		✓		### ₂
1 ¹⁰ UG		♀	23	Science	UG	✓			
1 ¹¹ UG		♀	22	Design and Technology	UG	✓			### ₁
1 ¹² PGCE	♂		26	Computer Science (SD)	PGCE (SD)		✓		
1 ¹³ UG		♀	22	Design and Technology	UG	✓			
1 ¹⁴ UG		♀	29	Design and Technology	UG	✓			
1 ¹⁵ UG	♂		28	Science	UG	✓			### ₁
1 ¹⁶ PGCE		♀	26	Science	PGCE		✓		
1 ¹⁷ PGCE		♀	26	Mathematics	PGCE (SD)		✓		### ₂
1 ¹⁸ PGCE		♀	31	Mathematics	PGCE	✓			
1 ¹⁹ PGCE		♀	42	Computer Science	PGCE	✓			### ₁
1 ²⁰ PGCE	♂		33	Computer Science	PGCE		✓		
1 ²¹ PGCE		♀	38	Computer Science	PGCE		✓		
1 ²² PGCE	♂		27	Computer Science	PGCE	✓			
1 ²³ PGCE	♂		31	Computer Science	PGCE	✓			
1 ²⁴ PGCE		♀	24	Computer Science	PGCE		✓		
FG1 ²⁵ PGCE	♂		41	Science	PGCE (SD)	### ₂		✓	### ₂
FG1 ²⁶ UG	♂		24	Mathematics	UG	### ₁		✓	
FG2 ²⁷ PGCE	♂		24	Mathematics	PGCE	### ₂		✓	### ₁
FG2 ²⁸ PGCE		♀	31	Design and Technology (SD)	PGCE (SD)	### ₂		✓	### ₂
FG1 ²⁹ UG		♀	34	Mathematics	UG	### ₁		✓	
FG1 ³⁰ PGCE		♀	49	Science	PGCE	###		✓	

Research phases, sampling techniques and participant engagement

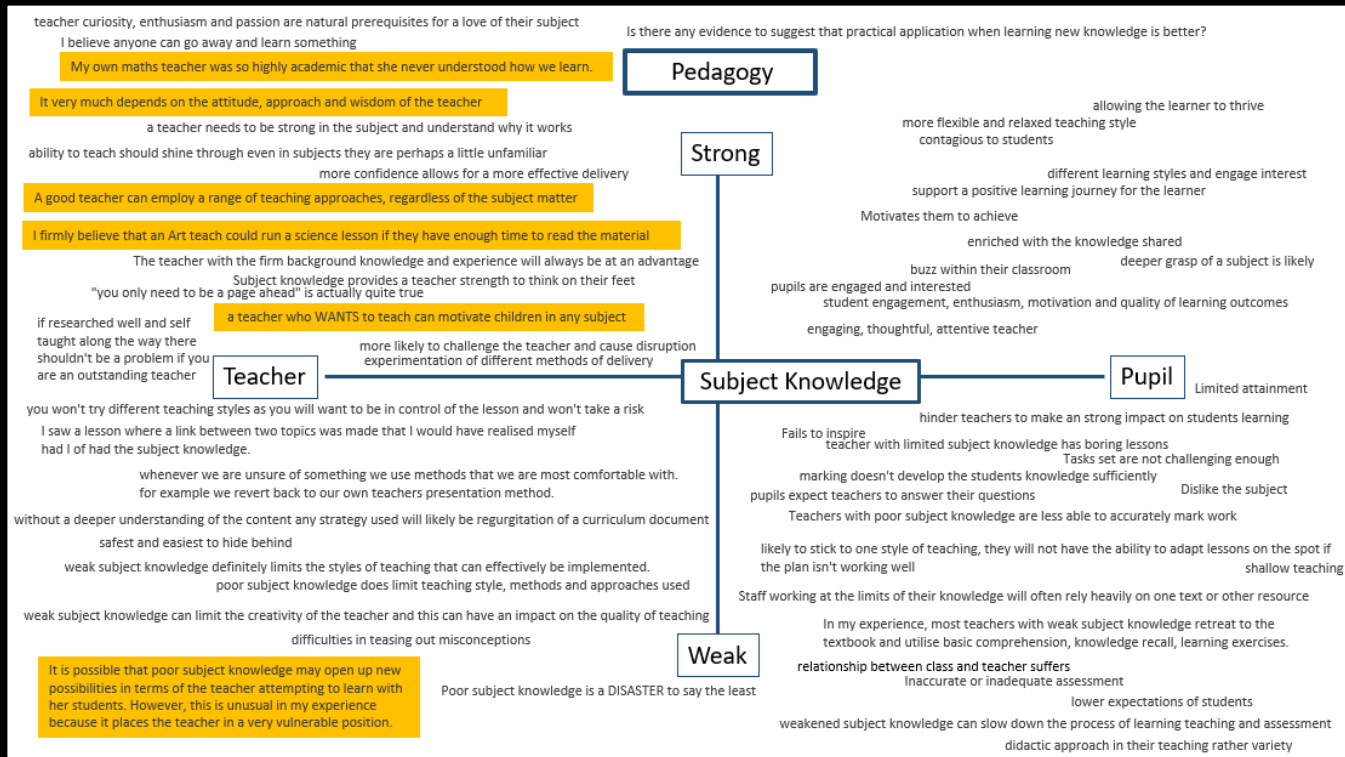
Recollections of being taught

The influence of one's own experience

Irrespective of their age, gender, or the STEM subject they were training to teach, in recalling memories of their own experience of being 'taught' as a pupil, participants recollections were 'vivid'.

Whether recalling a pleasant (positive) or unpleasant (negative) experience, the detail given was so precise that it was as if the event had happened only days earlier rather than years ago.

- Making a difference (to children and young people)
- External influences (experiences and people)
- Struggle (leading to potential anxiety)
- Aspirations and Influences (to be a good teacher)
- Attributes (of a good lesson, of a good teacher)



Boundary: 2nd Phase Focused Coding - Limitations - Knowledge - Confidence - Tolerance

I wasn't confident in what I was talking about.

then you've got another set of problems and if you're not confident

I had no idea what I was doing

I usually panic if I don't know

I didn't even know what it was and we had to do controlled assessment and I had to teach them.

I'm not er, too knowledgeable about it

they want me to start, and it's daunting

it just got quite complicated very quickly

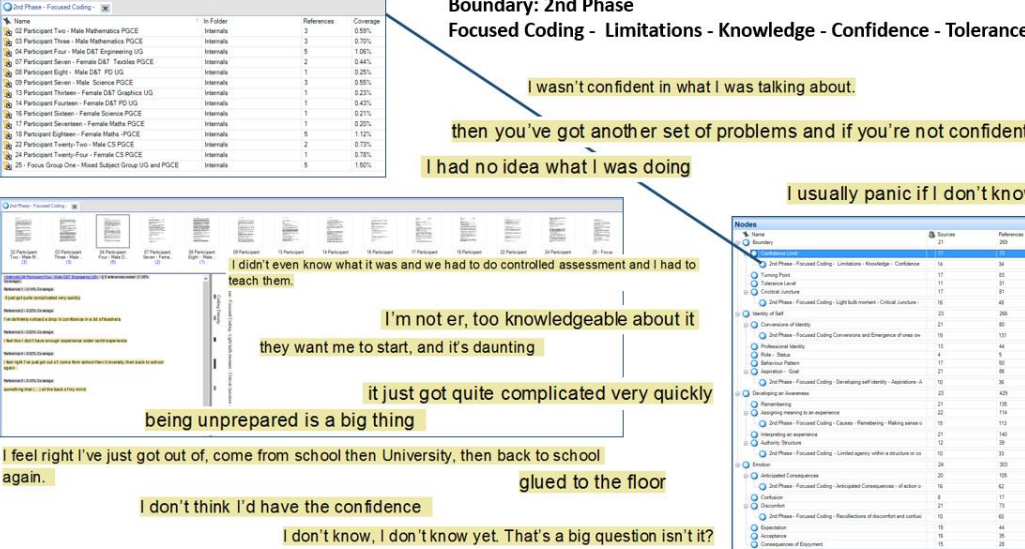
being unprepared is a big thing

I feel right I've just got out of, come from school then University, then back to school again.

glued to the floor

I don't think I'd have the confidence

I don't know, I don't know yet. That's a big question isn't it?



Substantive Codes:

Boundary

1. Limitations; Knowledge, Confidence, Tolerance
2. Critical Juncture; Light bulb moment, Turning Point

Identity of Self

1. Conversions and Emergence of ones owns identity
2. Developing Self; Aspiration, Achievement Orientation

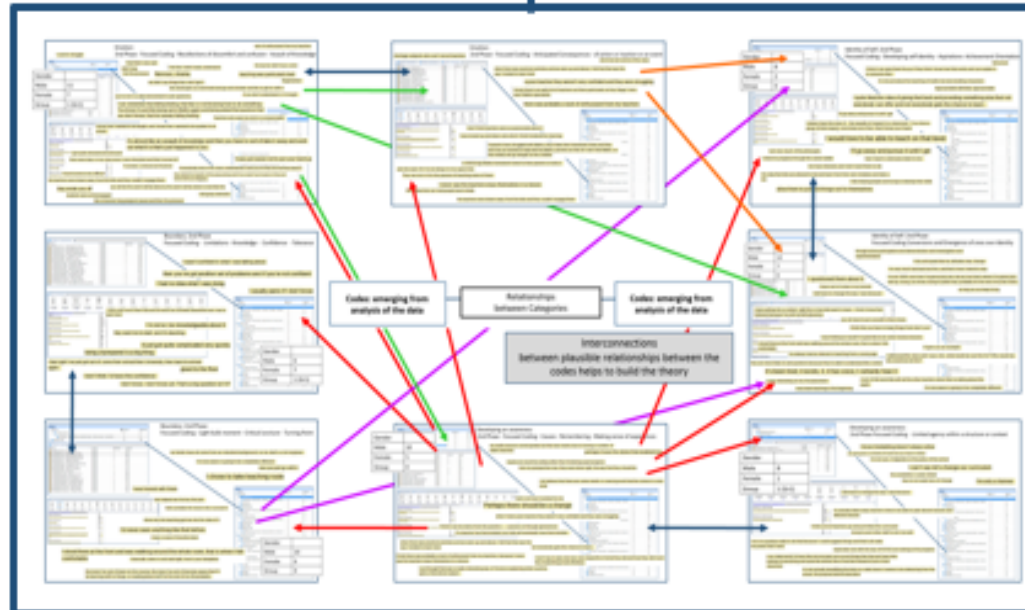
Developing an Awareness

1. Causes; Remembering, making sense of experiences
2. Context; Limited agency within a structure

Emotion

1. Anticipated Consequences; of an action, inaction or an event
2. Recollections; Discomfort and Confusion

Developing the substantive codes



Further analysis and the constant comparison of the focused, selective codes, has led to the generation of these substantive codes.

Building upon these codes the next stage will involve theoretical sampling, which once undertaken, through data analysis will lead to the creation of theoretical codes.

Feelings and Behaviours
(Teacher well-being)

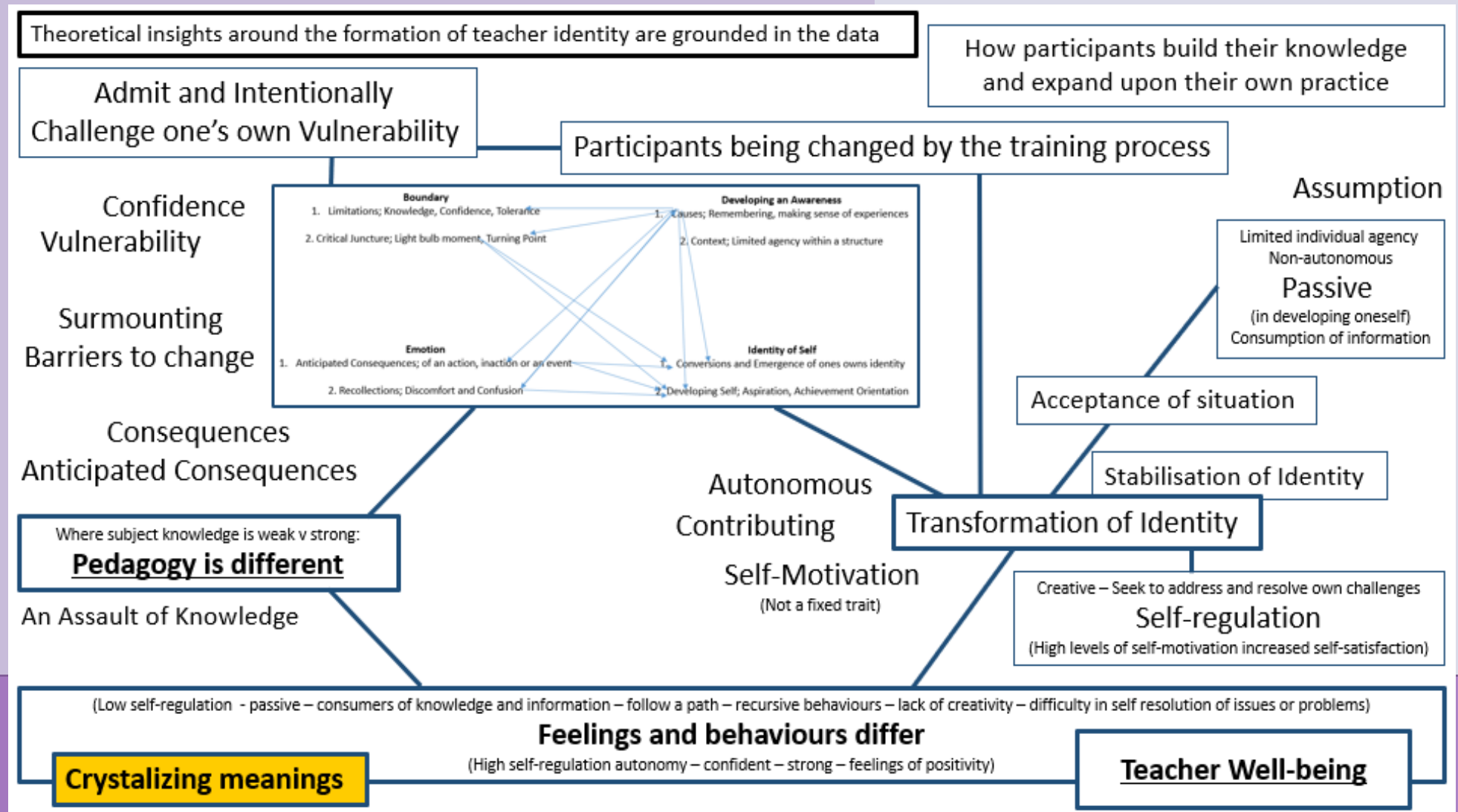
Subject Knowledge

Consequences
(Decisions, Action or inaction)

Pedagogical Approach
(is different)

Developing Identity
(Transformation – intentionally challenge oneself)

Emergent interconnections



Between first and second phase data (Substantive codes leading to the generation of theoretical codes)

Subject Knowledge

There is a specific type of ‘anxiety’ around a lack (or perceived lack) of STEM subject knowledge

- Pedagogy. The range of activity undertaken in the classroom, with very little ‘hands on’ work undertaken where pupils are engaged in the practical application of theory.
- Pupil learning and progress, their enjoyment and ultimately their longer-term engagement with STEM subjects.
- Teacher efficacy and well-being. Adverse impact on work-life balance due to increased time spent on lesson planning, preparation and assessing.

“deeper knowledge of one's subject allows for a more flexible and relaxed teaching style”.
It helps to make not only the teacher feel confident, but also gives the students a sense of confidence in their teacher's abilities.

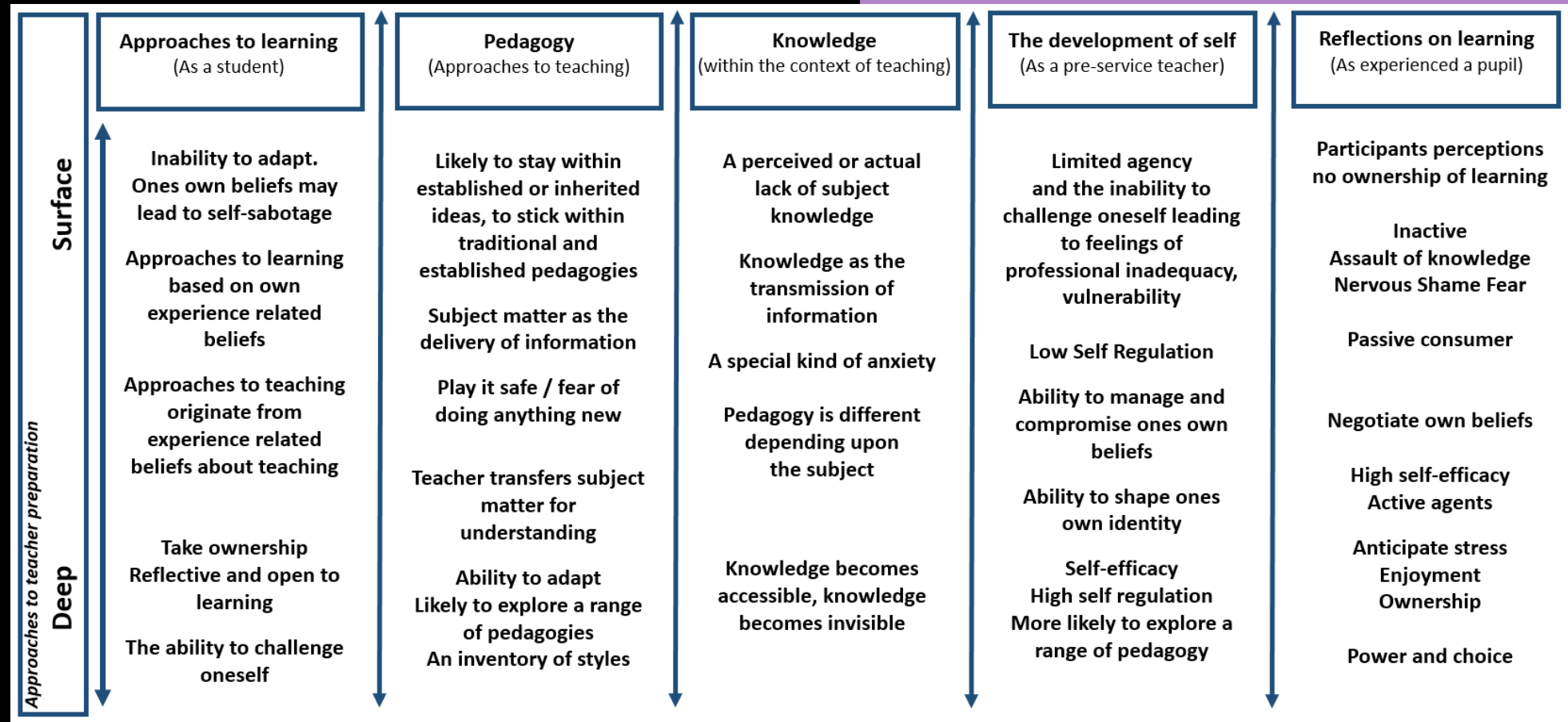
Becoming a Teacher

Feelings and behaviours differ depending upon the individual's personal approach (to learning and teaching):

- Where an individual's approach to learning is deep, and autonomy and self-regulation are high, confidence is increased and approaches to pedagogy are amplified.
- Where an individual has limited agency and their approach to learning is passive (surface), as a consumer of knowledge, self-regulation is low, and feelings of professional inadequacy and vulnerability thrive.

Transforming one's identity, moving from pre-service to qualified teacher means finding the strength to challenge oneself. To surmount effectively barriers to change, one must be able to admit and intentionally challenge one's own vulnerability.

Approaches to, and engagement with *pre-service teacher preparation*



A correlation between approaches to learning and teaching, knowledge, and the development of self and reflections on learning

1. An 'Assault of Knowledge'

There is a specific type of 'anxiety' around a lack (or perceived lack) of STEM subject knowledge

According to Shulman (1986) there is '*a growth in knowledge of teaching*' specific to the process of converting subject matter for the purposes of teaching, but what if, during the process of training, the pre-service teacher perceives that their knowledge is limited, and they do not have enough specialist subject knowledge to transform?

“the worst lesson definitely is where the teacher’s just standing there, and it’s almost like an assault of knowledge and then you have to sort of take it away and work out what it is that’s just happened to you”

An 'Assault of Knowledge'

This describes a '*pedagogical subject gap*', a '*space*' or '*gap*' in a pre-service teacher's subject knowledge that has the potential to harm the formation of a teacher's identity.

The impact of weak subject knowledge on development is significant. Where a pre-service teacher has inadequate subject knowledge they struggle to know what they are teaching, or why they are teaching what they are teaching.

A specific type of anxiety that forms around this '*lack*' (or perceived lack) of subject knowledge.

This insight refers to the liminal moment where if present subject matter transforms to become PCK.

This is in the '*space*' where a beginning teacher's identity begins to form.

Where subject knowledge is absent, this prevents the pre-service teacher from developing their ability to transform subject matter into pedagogical content, which makes knowledge accessible to a learner.

2. *The notion of self-sabotage*

For those training to teach, the meanings they assign to their own experience, that is to say the pre-service teachers self-constructed personal philosophy and their ideological beliefs, views, and opinions, has the potential to lead to the unintentional self-sabotage of their own emergent professional identity.

Self-sabotage is where the pre-service teacher is unable to move beyond their internally imposed boundaries and damages their own development, unintentionally incapacitating themselves and halting the formation of their professional identity.

Where there is an inability to challenge one's own experience-related beliefs, and personally held perceptions of '*what a teacher should be*' or '*how a teacher should act*' this can lead pre-service teachers to engage in unintentional self-sabotaging behaviours.

Self-sabotage manifests as unpleasant feelings of uncertainty and of being powerless. This in turn leads to the lowering of self-esteem and conditions that serve only to limit the formation of an individual's professional identity.

An inability to challenge one's own experience-related beliefs, and personally held perceptions of '*what a teacher should be*' or '*how a teacher should act*' can lead pre-service teachers to engage in unintentional self-sabotaging behaviours.

The meanings assigned to experience has the potential to lead to the unintentional self-sabotage of emergent professional identity

Self-sabotage manifests as unpleasant feelings of uncertainty and of being powerless. This in turn leads to the lowering of self-esteem and conditions that serve only to limit the formation of an individual's professional identity

The notion of self-sabotage

Unaware

There is no conscious awareness on behalf of the individual that their actions, attitudes, or behaviours are potentially contributing to the sabotage of their own professional development. Consequently, there is no awareness; the individual is unaware (oblivious) to any negative impact upon the development or formation of their own identity.

Difficulty

The individual may have limited belief in their own agency to influence the structures within which they are working or believe that they have limited credence to implement their own ideas and to make independent choices or to make decisions. The individual may experience significant difficulty engaging with authentic self-reflection, which may serve to impede identity development.

Reluctance

The individual is reluctant (or there is a disinclination) to adopt new or unfamiliar pedagogical approaches. They may have a fear of failure or have limited belief in their own (pedagogical) abilities; they may be closed to the concept of adopting a pedagogical approach, or to explore new and emerging pedagogical practices.

Inflexible

The individual is inflexible in their approach, which manifests internally and externally as a resistance to change. In practice, this creates barriers to embracing anything perceived by the individual as different or new, irrespective of the origin of the idea or pedagogy being considered.

Rigid

The individual is rigid in their approach, unable, or unwilling to move from their established views and beliefs. There is an inability to change, or to challenge personal philosophy, ideology and opinions of how a teacher should be, act or behave.

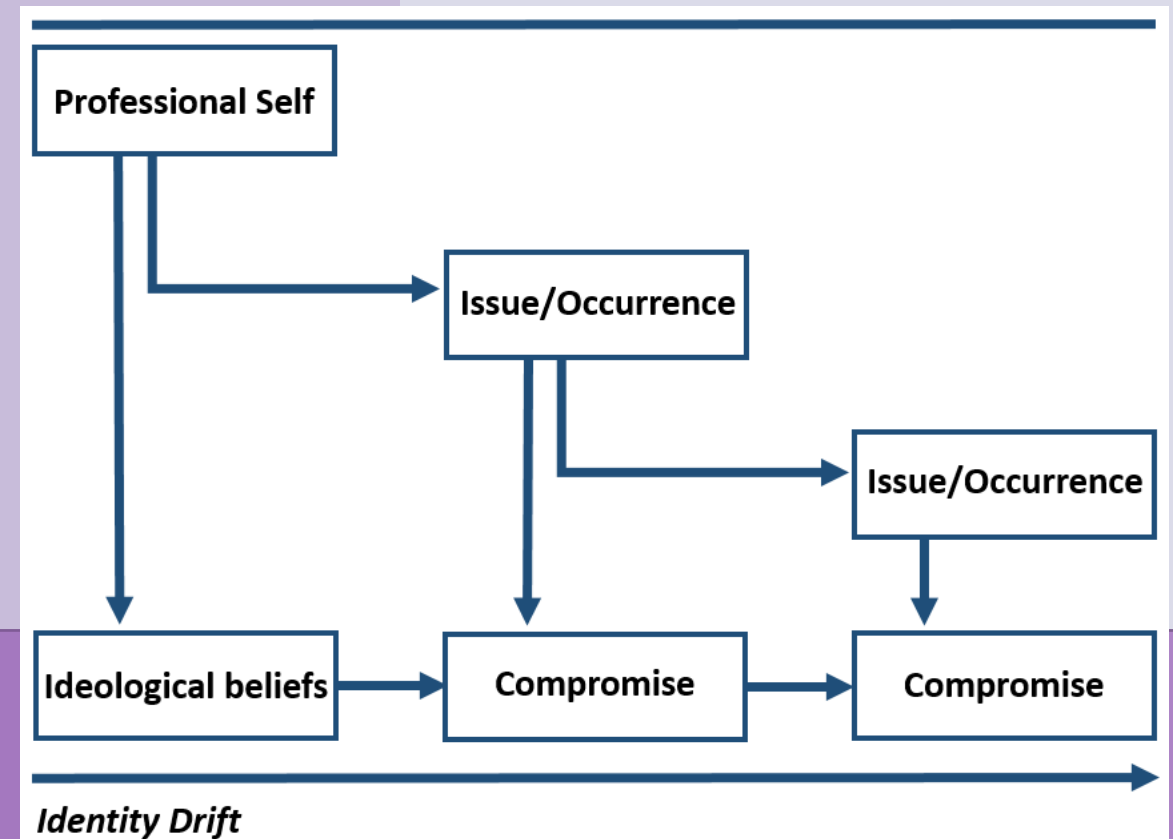
A Classification of Self-Sabotaging Behaviours

1	Unaware
2	Difficulty
3	Reluctance
4	Inflexible
5	Rigid

3. The notion of Identity Drift

Identity is not a fixed trait; it is continually re-shaped by the meaning assigned to experiences; a process that involves the constant negotiation between one's personal philosophy and the reality of practice. Successful and sustained teaching is the careful negotiation, and in some cases the constant compromise, of one's own deep-seated views, values, opinions, and beliefs.

The inability to continue to manage the space between ideological beliefs and the reality of classroom practice drift so far apart the individual is unable to reconcile their internalised identity from their external one. The gap between ideological beliefs and actual reality widens beyond a tolerable limit. The likely outcome is teacher attrition.

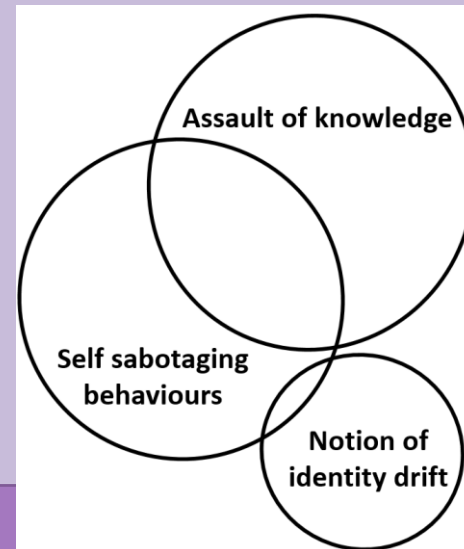


Teaching as a compromise: The notion of 'identity drift'

Interrelationships between theoretical insights



Theoretical insights: Independent influences on identity



In this exemplar subject knowledge is developing, and as identity forms some potentially self-sabotaging behaviours are occurring. At this stage while ideological beliefs are challenged, they are not tested to the extent where attrition is likely to occur.

The potential profile of a pre-service, or early career teacher

Personal reflections ...

A review of success and failures

I undertook this study because of my personal interest in STEM education and my concerns in relation to teacher shortages, the recruitment and retention of specialist STEM teachers.

My motivation was to gain an understanding of how pre-service teachers approaches to learning, and subsequently their approaches to pedagogy are shaped by their subject knowledge and the meaning they have assigned to their experience related beliefs.

Early stages.

I envisaged findings would converge and steer me toward the generation of a STEM pedagogical framework. While a favoured pedagogy did emerge (applied approaches) as my research progressed (and my own abilities developed) it became clear that to advocate a single delivery approach would be both naïve and counterproductive.

Personal reflections ...

Through an iterative process of concurrent data collection and analysis, findings emerged and theoretically coded data was refined to bring to the fore three key outcomes.

Themes unexplored.

Decisions about which themes to develop were based on the richness of participant data. Those I didn't progress included female pre-service teacher's engendered pedagogical approaches to the delivery of STEM subject disciplines. The impact on identity and motivation of teachers engaged in the delivery of those STEM subject disciplines perceived by some (Paechter, 1993, 2002) to be of lower status. The impact of teacher anxiety on pupil progress, attainment.

While work undertaken was within the context of STEM many outcomes maybe of potential interest to those engaged in the training of pre-service teachers beyond the STEM subject disciplines explored here.

Concluding thoughts...

Teachers' beliefs are shaped by their sociocultural background, their childhood memories, their life and work experiences.

Teaching requires the emotional immersion into one's work (Nias, 1996) and understanding oneself is a crucial element in the successful formation of a teacher's professional identity (Kelchtermans, 2005; Day *et al.* 2006; Beauchamp & Thomas, 2009).

When feelings of professional inadequacy grow, (interpretation of own performance), when for example an individual believes they have limited subject knowledge, their ability to develop fully their own professional identity and self-efficacy is restricted.

Findings suggest a perceived lack, or actual weakness in subject knowledge limits pedagogical approach and teaching style(s) are constrained. Consequently fewer 'risks' are taken. Teachers seek to stay within their pedagogical safe space.

Rather than utilising innovative pedagogy or student-centred approaches teaching is reduced to the delivery or transmission of knowledge which can foster surface approaches to learning (Trigwell *et al.* 1999).

...and implications for policy and practice

Aligning with Pinnegar *et al.* (2011) and Beauchamp and Thomas (2009) findings suggest tangible benefits in supporting pre-service teachers of STEM to be aware of the meaning of their experiences related beliefs.

Identity is not a fixed trait. Professional knowledge and beliefs held by teachers are shaped and reshaped in response to new experiences. Once qualified teachers are unlikely to adapt their established pedagogical practice (Herckis *et al.* 2017). Therefore, it is desirable for teachers to enter the profession as independent, confident practitioners, with the capability to explore approaches to learning and teaching.

Findings advocate the implementation of policy, guidance or a code of practice that scaffolds where reflection is encouraged. Creates opportunities for pre-service teachers which enable them to become agents of their own change, equipped with the tools (knowledge) to re-shape their own professional identities beyond the initial training period.

Structured support to enable successful challenges to beliefs that may (unintentionally) be impede development which if left unchecked is likely to lead to identity drift and attrition.



*Thank you
for taking the time to come along this afternoon
...and I am happy to answer any questions*



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