Teaching patients about pain: the emergence of Pain Science Education, its learning frameworks and delivery strategies

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Abstract

Since it emerged in the early 2000's, intensive education about 'how pain works', widely known as pain neuroscience education or explaining pain, has evolved into a new educational approach, with new content and new strategies. The substantial differences to the original have led the PETAL collaboration to call the current iteration 'Pain Science Education'. This review presents a brief historical context for PSE, the clinical trial, consumer perspective and real-world clinical data that have pushed the field to update both content and method. We describe the key role of educational psychology in driving this change, the central role of construvism and the constructivist learning frameworks around which PSE is now planned and delivered. We integrate terminology and concepts from the learning frameworks currently being used across the PETAL collaboration in both research and practice – the Interactive, Constructive, Active, Passive (ICAP) framework, transformative learning theory, dynamic model of conceptual change. We then discuss strategies that are being used to enhance learning within clinical encounters, which focus on the skill, will and thrill of learning. Finally, we provide practical examples of these strategies so as to assist the reader to drive their own patient pain education offerings towards more effective learning.

Perspective
Rapid progress in several fields and research groups has led to the emergence 'Pain Science Education'. This PETAL review describes challenges that have spurred the field forward, the learning frameworks and educational strategies that are addressing those challenges, and some easy wins to implement and mistakes to avoid.

Key words
Explain pain, constructivism, educational psychology, active learning, deep learning.

1. *Introduction and the emergence of Pain Science Education*

Pain science education (PSE) is the contemporary iteration of what first emerged as 'intensive neurophysiology education'[1] and then became widely known as 'pain neuroscience education' [2] or 'explaining pain'[3]. The aim of the intervention has remained consistent - to increase one's understanding of their own pain so as to equip, enable and empower them to make optimal decisions about how best to manage and treat it[3]. Its original iteration – pain neuroscience education – has now been tested in 78 published randomised controlled trials, but the field is moving quickly and has revealed both suboptimal outcomes and exciting opportunities. This review provides a 'state of the art' position statement from field leaders, regarding how consideration of learning frameworks and better strategies and resources are transforming pain education and should drive better consumer outcomes. We aim to provide a historical context for PSE and its emergence from the earliest iterations, describe the key learning frameworks around which PSE is planned and the strategies that are being used to enhance learning within clinical encounters. This review is guided by the scale for the quality assessment of narrative reviews (SANRA)[4] (see Appendix 1).

2. *The initial development of 'explaining pain'*

The initial development of 'explaining pain' as it was first called, was triggered by building evidence that the biopsychosocial model of pain and the treatments based upon it (primarily cognitive behavioural therapies) contrasted with consumers' and health professionals' understanding of the biological processes underlying pain[5]: as long as one understands pain to be an accurate marker of the state of one's tissues, then looking beyond the tissues for contributors to pain and possible treatment options may well appear to be nonsense[1,5,6]. That is, by the mid-1990's, there had emerged a vast disconnect between the scientific understanding of pain (including its protective function, its multifactorial nature, its dynamic nature over time, and the most effective ways of treating it) and the dominant understanding of 'how pain works' held by consumers and health professionals alike[5].

These first iterations were highly didactic, often delivered in the form of a small group seminar or through one-on-one provision of information[6], by allied health professionals, psychologists and nurses. The approach became widely known as 'pain neuroscience education' (PNE) and as such 'PNE' will be used throughout this paper to refer to pain education interventions that have varied little from those early iterations. Early randomised controlled trials (RCT) of PNE demonstrated small benefits over conventional 'back school' type education and over usual care, on movement-evoked pain, pain-related worry, pain and disability[1,6,7], in individuals with chronic pain.

The learning objectives and content of PNE were developed informally on the basis of the lived and clinical experience of a single clinician researcher. The content used in those early RCT's was then integrated with the perspectives of an experienced clinical educator and produced in book form in what arguably remains the key content resource in this field – *Explain Pain*[8,9]. With few exceptions, the content and delivery of PNE, which has now been tested in over 78 clinical trials, remained broadly consistent with *Explain Pain*[8] and those early trials. A major update of *Explain Pain* in 2013[9] led to shifts in content for subsequent RCTs, but clinical opinion pieces and implementation have continued to advocate this didactic approach[10,11,12]. Indeed, many of us have heard clinicians report that they now 'give the pain talk', 'explain pain' or '*do* PNE'. Despite its promise, important limitations of this

early and standardised approach have become clear, for example: chronic pain conditions differ in their underlying biology, and so do individuals; engagement in PNE can be difficult; the content of PNE can contrast significantly with the remainder of the clinical management approach and treatment package.

Despite the limitations of PNE, meta-analyses clearly show small to medium clinical benefits across a range of chronic pain conditions, in a range of languages and settings[13–19]. However, clinical audit of patients who have participated in PNE[20], delivered by physical therapists, exercise physiologists, nurses, social workers or clinical psychologists, revealed two important patterns that place the RCT data into context. First, when the learning objectives of PNE *are* achieved, patients tend to gain excellent and sometimes transformative pain and disability-related outcomes. Second, the learning objectives of PNE are achieved in about 50% of patients. Critical here is the clear evidence that pain and disability did not improve in those patients who did not undergo conceptual change. This finding is corroborated by qualitative appraisal of patient responses to PNE.[21–23] This observation is both confronting – we have not been doing very well at instilling deep learning – and exciting – if we can do better, better clinical outcomes should follow. These issues have been driving the field towards improving the content and delivery of PNE so as to achieve better learning and clinical outcomes. This has meant significant changes in theoretical rationale, content and delivery, such that contemporary iterations vary substantially from the initial PNE. To make this differentiation from PNE clear, the PETAL collaboration chose to refer to contemporary iterations as 'Pain *Science* Education' (PSE). It is important to note that PSE reflects an evolution from PNE over time, rather than a brand new intervention developed 'from the ground up'. The new term fits the new intervention well: *content* has expanded to include findings from beyond neuroscience (e.g. immunology, psychology, endocrinology) and to focus on learning objectives reported by recovered consumers to have been most important for their recovery[24–26], and implementation has been transformed by education science (see Table 1).

INSERT TABLE 1 ABOUT HERE

The need to improve PNE is corroborated by the perspectives of consumers, who have clearly identified better pain education as a high care priority[27]. In a recent RCT of a complex chronic back pain intervention, grounded in PNE, participants found the PNE component of multimodal care the most difficult; some did not expect nor want to have someone 'talk to them'; some felt it invalidated their experience; some felt the concepts were simply too difficult to understand[28]. Health care professionals (HCPs) are also challenged. Some remain resistant to the content[29]; others may feel that a beneficial cognitive intervention undermines their physical rehabilitation skills. In our clinician-researcher networks across countries, HCPs consistently report that they stopped seeing PNE as a mandatory part of pain care "because it is too hard and most patients don't want it"[30,31].

3. The role of educational psychology in developing PSE

The last five years of development in PSE has been primarily influenced by two broad branches of educational psychology: the well-established learning field, which focusses on school-based learning; and the emerging field of conceptual change[32,33], which takes a broader look at life-long learning. The conceptual change field accepts that learners come

with existing conceptions and misconceptions and that cognitive, metacognitive, behavioral, motivational, and emotional/affective factors all influence the extent and speed of learning. These latter aspects are the focus of self-regulated learning models[34,35,35] that have also been prominent for decades but are currently undergoing rapid development and modification according to the changing requirements of adult conceptual change and available technical innovations (eg virtual reality[36]). Self-regulated constructivist learning models include, alongside content to be learned, 'learning about learning' (e.g., self-efficacy, cognitive strategies) and these considerations are now integrated into patient-facing PSE resources (eg.[37]).

This substantial and rapidly growing body of knowledge presents remarkable opportunities to those of us in the patient and public targeted pain education field, and to health education more broadly, because a massive amount of work has already been done for us. Here we discuss three key opportunities that are pushing the PSE field forward: (i) adopting, as many education experts have, a constructivist approach to learning; (ii) designing our pain education offerings using established educational frameworks; (iii) implementing evidence-based strategies to optimise engagement and learning within those frameworks, in order to improve consumer outcomes.

4. A constructivist approach to learning can guide better PSE

Adopting solid educational theory for the planning and delivery of health education is long overdue. Of the many useful educational theories, constructivism has been most influential in the emergence of PSE from its PNE roots. Constructivism is an approach to learning first presented 50 years ago[38] that posits that people actively construct their own knowledge on the basis of their experiences as a learner, rather than acquiring it passively through a process of knowledge transmission. That is, rather than being a passive recipient (as is the case in 'PNE'), constructivism considers the learner as an active agent in the process of knowledge acquisition (as is the case in the contemporary PSE approach). Learners fit new information together with what they already know; educators ensure they understand the learner's pre-existing conceptions and misconceptions, and guide activities to address and then build on them. A constructivist approach emphasises the value of identifying a learner's prior knowledge. If a learner holds beliefs that are in conflict with to-be-learned concepts,[e.g.3] then education requires the learner to form and adopt a new, dominant concept to explain a phenomenon. The field of education that explores the processes by which a learner changes their understanding of a phenomenon (e.g. pain) in the presence of existing knowledge is conceptual change.[33] Constructivist learning approaches have had their critics both in the psychological sciences[39] and in regards to patient education[40] but their evidence base supports their longevity, with several constructivism-based learning frameworks, proven in other educational settings, informing the transformation of PNE into its present PSE form.

5. There are multiple PSE-suited constructivism-based learning frameworks

Dozens of constructivism-based learning frameworks have been described and several have been particularly influential in guiding development of PSE (see[41]): Interactive, Constructive, Active, Passive (ICAP) Framework[42], Transformative Learning Theory[43], and the Dynamic Model of Conceptual Change[44].

The ICAP Framework

Development of PSE within clinical practice and for the planning of current clinical trials has drawn heavily on the Interactive – Constructive – Active – Passive, or 'ICAP' framework presented by Chi and colleagues[42] and adapted specifically to PSE in Moseley & Butler.[41] The ICAP Framework endorses the relative benefit of active (i.e., 'doing' something with the content to be learnt) and self-regulated learning[35,45,46] and extends it in two ways: by establishing a hierarchy of learning (from Passive to Interactive) and considering engagement from not only motivational, behavioural or emotional perspectives, but also from a cognitive perspective.

The ICAP Framework has led to changes in the activities, the knowledge-change processes thought to be involved, and the resultant cognitive and behavioural outcomes of that knowledge change. That is, the ICAP framework guides the sequential use of (i) metaphor and story (e.g.[47]) ('enhanced passive'), (ii) scientific explanation (passive), (iii) active or thought experiment (active + constructive)(see Table 2). Another application of the ICAP framework to PSE has given rise to the 'pain conceptual change' framework.[41] This framework has been presented in detail elsewhere,[41] but includes consideration of both the *extent* of current misconceptions, from 'grain' level (minor; reconceptualization is easy) to 'sandstone' level (major; reconceptualization is very difficult) and the *type* of misconceptions, for example in not conceiving emergent patterns (see[41] for detailed discussion).

Transformative Learning Theory

Transformative learning aims to change the way individuals perceive and experience the world. It is a process of effecting change in one's 'frame of reference', or the 'structures of assumptions' through which we understand our experiences of pain[48]. These frames of reference can include cognitive, conative, and emotional components and consist of two dimensions: habits of mind and a point of view. Habits of mind are seen to be broad, habitual ways of thinking, feeling, and acting and they become articulated in a specific point of view — that is, the constellation of pain beliefs, attitudes, and feelings that shape a particular interpretation of pain.

According to Transformative Learning Theory, changing perspectives and broadening meaning structures requires a 'disorienting dilemma'. These dilemmas occur when individuals have experiences that do not make sense to them or fit in with their beliefs and ideals. Educators aim to create conditions (e.g., cognitive dissonance) that provoke 'aha moments' where learners see a problem from a new perspective and discover solutions that were obscured from view by previously held views or beliefs. Educators provide the space and opportunity for critical, guided reflection to encourage the learner to re-examine their beliefs and attitudes, allowing for change in their frame of reference. Educators then guide the learner to consciously make and implement plans that bring about new ways of defining their worlds. The crossover between phases of Transformative Learning framework and the ICAP framework is presented in Table 3.

Approaching PSE within a transformative learning theory would lead educators to help learners become critically reflective of their assumptions about pain as the pathway to transforming the frames of reference by which they make sense of their pain. Important here is that one does not make transformative changes when new content can be accommodated by existing frames of reference for pain. Transformative learning can be captured in patient

reports of their own journey: *"I really looked through a different lens then, I have changed substantially…."* (Beetsma et al UNPUBLISHED DATA).

Dynamic Model of Conceptual Change

The Dynamic Model of Conceptual Change (DMCC)[44] highlights the dynamism and complexity of conceptual change by identifying different elements and processes at play during conceptual change. Understanding these processes may be helpful to inform the optimisation of PSE delivery. In the DMCC, the stages of learner recognition and consideration of the message, engagement in processing the message, and conceptual change, are self-regulated by the learner and influenced by the learner's motivation, society, culture, emotions, personal epistemology, extant knowledge, attention allocation, and personal behaviours and practices.

Another consideration that is core to the DMCC is the learner's extant knowledge – or current conception – 'old' ideas (extant knowledge) often subsume ideas of caregivers, partners, family members and peers, and can inform and constrain learning. This has clear overlaps with the ICAP Framework's 'category of misconception' noted above. How resistant to change a learner's existing ideas are depends on multiple factors, including its strength (how sticky is it?), its coherence (how well does it fit together?) and the learners' commitment to it (how willing are they to change their idea?). Of clear relevance here is the learner's motivation to take action to engage cognitively, emotionally and behaviourally in PSE. Motivation is an expression of the autonomy of individuals in their determination to consider (or not) alternative explanations and form new conceptions. According to the DMCC, three key factors drive motivation: relevance (personal importance); task-value (usefulness, cost, attainment likelihood); learning goals (mastery and performance goals). Certainly, consumers of PSE have reported that they are not motivated to engage in PSE when they perceive it as personally irrelevant.[21–23]

Possible conceptual change outcomes can be considered on a spectrum. At one end of the spectrum is the formation of a new conception with no acceptance, resulting in a new, but dormant conception and the original conception remains dominant. At the other end of the spectrum, enduring transformation, learners understand, accept, and actively commit to the new concept. At this level of conceptual change, the learner understands the new concept, accepts the premise of the concept and is so actively committed to the idea that there are changes in lifestyle, behaviours and actions. It is important to note that the DMCC holds that a conception is not lost but rather can become submissive to the dominant conception. This may in part explain the phenomena elucidated by the PSE qualitative research that individuals can often hold multiple contradictory conceptions of their pain[21–23]. Further, once a conception is dominant (or submissive) it may be reappraised during the process of 'dynamic contemplation'. Dynamic contemplation can explain patient reports like this: "I don't think there is a relationship between pain and tissue state because in 16 years of pain I've not had any proof anything is wrong with the tissues, even if it feels like there is but in that moment when the pain is severe I'm thinking oh my god what's wrong"[49]. In such cases, individuals have previously reconceptualised their understanding of pain in alignment with PSE but return to a biomedical model during a flare up in pain.

INSERT TABLES 2 AND 3 HERE

6. *Pain Science Education uses contemporary strategies to optimise learning and behavioral outcomes*

The other significant contribution made by contemporary learning and education sciences to the implementation of PSE concerns strategies that can be used to optimise learning. Learning strategies are ways to enhance *how* one learns, *how well* one learns, and how well one's learning can be *generalised and expanded* beyond the content or context of learning. They may be strategies used by the educator/HCP or the learner/patient.

There is a mountain of empirical data around learning strategies. For the sake of brevity, we focus here on the most comprehensive empirical account thus far undertaken[50]. Hattie and Donoghue[50] reviewed 228 meta-analyses of learning strategies, with a total sample of over 11 million participants. They synthesised their results within the context of three sources of inputs – 'skill', 'will' and 'thrill' – and three phases of learning – surface, deep and transfer (see Tables 2 and 3 to contextualise this in terms of constructivism and learning frameworks). Hattie and Donoghue[50] match the outcomes of learning to the inputs, where 'skill' refers to the learner's prior and subsequent achievement (or understanding), 'will' refers to the learner's attitude towards learning (for example 'is education about pain a worthwhile endeavour?'), and 'thrill' refers to the motivations of the learner (for example to reduce pain, manage it better, or develop skills and mindsets that apply beyond the current health challenge).

Strategies to enhance 'skill'
Hattie and Donoghue's meta-analyses[50] identified 302 effects from almost 19 thousand primary studies. The average (range) effect size of a learning strategy on learning performance, from all meta-analyses, was 0.5 (0.17 – 1.09). Meta-analyses that focussed on changes in learning outcomes ('skill') revealed a larger mean effect size (0.75) than those that focussed on attitudes ('will') and motivations ('thrill'). Within the 'skill' focussed analyses, only 'prior learning' and 'working memory' consistently demonstrated important effects. Here, 'prior learning' refers to aptitude and experience or training in 'learning', the most accessible (but, notably, imperfect and incomplete) marker of which would be educational attainment. 'Prior understanding' however, refers to one's current concepts of things and is most often a barrier to PSE because the dominant understanding of 'how pain works' aligns with a single pathway model of pain as a marker of damage.

The importance of both prior understanding and prior learning/learning aptitude is an important consideration for PSE because it compels us to consider the learning history and learning needs of our patients: those with low aptitude or experience in prior learning and those with poor working memory, are likely to find learning outcomes more difficult to obtain (see also 'aspects of the learner' in Moseley & Butler[41]). Clear health disparities exist across a range of social factors of which educational attainment is just one. Research into the social determinants of pain outcomes is limited relative to other health fields, although it is building[51–53], and the importance of screening for social needs in pain care has been recognised[54] (see the ISSHOOs project https://www.isshoos.org/). That health education strategies have historically failed to improve the health of those who most need it, and thus increase health disparity[55], deeper consideration of the learning needs of people in pain, as well as their broader social context, and giving voice to under-represented groups in the

planning and implementation of PSE, will all be critical to increase the impact of PSE moving forward.

Relevant here is the notion of cognitive flexibility, which has been linked to chronic pain in rats[56] and humans[57]. Despite its intuitive appeal, the notion of cognitive flexibility is problematic, with little consensus on definitions, assessment or interpretation[58–60], and no relationship between self-report and neurocognitive assessment results despite supposedly targeting the same underlying constructs and processes[58,59]. Moreover, when confounders are controlled for, people with chronic pain do not demonstrate impairments on neurocognitive or self-report assessments of cognitive flexibility (Howlett et al UNPUBLISHED DATA). However, there are several studies that demonstrate impaired working memory[61] and executive function[62] in people with chronic pain, which adds weight to the importance of considering 'prior learning' as well as 'prior understanding' when planning and implementing PSE. Moreover, medications and comorbid sleep impairment may affect working memory and executive function and potentially impact the nature and timing of PSE. It may be that significant sleep impairment needs to be addressed prior to engaging in PSE.

One step towards reconceptualization is that the learner becomes dissatisfied with their present understanding of something. This is a critical consideration for PSE because it reflects a common situation – that the person in pain is often not only satisfied with their current understanding of 'how pain works', but is motivated to remain committed to it[24,25,27]. This situation may be related to the role of validation within the clinical encounter[63] – people with chronic pain report often feeling that their pain and experience has not been validated[64], a situation observed within qualitative appraisal of patient experiences in PNE trials mentioned earlier. Such invalidation may well increase motivation to hold on to current understanding of what pain means. In PSE practice, this supports the notion of spending time with the patient initially to learn their story and their understanding of their pain, explicitly validating their pain, its impact on their life, how it makes them feel more broadly, their fears, worries and behaviours. Validation of pain and feelings associated with it was a care priority voiced by consumers with pain,[27] was considered a critical aspect of communicating with children about pain[65], and was identified by patients as a facilitator of outcomes in a back pain complex care package, centred around pain education[28,66]. Anecdotally, PSE practitioners from across disciplines can confidently and easily validate a patient's pain without resorting to validating a patient's injury or 'broken body', which may well have counterproductive results. Socratic questioning can help patients identify inconsistencies and gaps in their pre-existing understanding[67]. This approach can not only enhance therapeutic alliance by maintaining validation[68], but also foster dissatisfaction with their current conception. It contrasts with 'the pain talk', which can be akin to 'telling people that their understanding is wrong', which is arguably invalidating and reduces therapeutic alliance. This process of fostering dissatisfaction with current conceptions while validating the patient's experiences and maintaining the principle of patient/learner centeredness, might be especially difficult outside of a clinical interaction – a challenge we necessarily face in community outreach and public engagement.

Within a clinical interaction however, the principle of patient/learner centeredness would seem critical and fits well within constructivism. We contend that not considering learners' perspectives and context is risky and that collaboration between consumers, health professionals and researchers is required to optimise educational offerings within both clinical and public health contexts[26]. The challenge of bringing modern pain science concepts straight to the general public, or at a population level, outside of the therapeutic encounter, is

covered in detail elsewhere.[69] Suffice here to emphasise that learning objectives and the strategies to achieve them will necessarily be very different if the learner is engaged in clinical care than if the learner is a passive recipient on, for example, social media.

Strategies to enhance 'will'
Meta-analyses investigating attitudes towards learning ('will') show some consistently effective strategies (Table 4).

With regards to PSE, there may be value in promoting messages about learning itself, for example through generic resources such as posters displayed in the clinic or waiting area, promoting learning as an important component of self-management. Learning objectives centred on 'our inbuilt bioplasticity'[70], with reflection on learning to ride a bike or play a musical instrument, or on the metaphor of 'kangaroo tracks' or 'the orchestra' in the brain[41], may serve to increase 'will', by shifting the learners' self-concept and improving self-efficacy for change. Strategies to enhance 'will' have also been integrated into general public-facing resources, for example the Pain Revolution factsheets 'Learn more about your pain'[71], which aims to impart the potential value of learning, and 'We are bioplastic'[72], which aims to shift the learner's self-concept around learning and change.

INSERT TABLE 4 ABOUT HERE

Strategies to enhance 'thrill'
Health education is often seen to be dull, uninviting, and boring – as captured perhaps in the monotoned, light-faded leaflets we have all seen in clinic waiting rooms. Such education is unlikely to thrill. The relatively recent arrival of the internet and social media, has opened up an array of health education formats that are arguably more interesting and engaging. However, important strategies that have shaped modern PSE and apply across delivery modes, are those that promote 'deep motivation' to learn. Deep motivation links both the intent of the learner and the strategies they adopt, with their learning-related behaviour[73]. Deep motivation is characterised by learners aiming to develop a deep understanding of what they are learning, be able to relate ideas together, compare and contrast different chunks of content, make direct connections with their own experiences and discuss their learnings with others[50]. Exposure to feared movements and behavioural experiments within the clinic can help establish or reinforce and consolidate key learning objectives[74]. Planning and implementing PSE with deep motivation in mind can be unsettling for health professionals who 'deliver' PNE, whereby the content is presented to a learner one 'hopes' will be receptive. However, when learners truly grapple with new content, identify and articulate their own dissonance and offer connections and contradictions to new content, it can be helpful to remember that these are 'deep learning behaviours' and consistent with conceptual change being underway.

Deep motivation, therefore, aligns with what constructivism would consider 'knowledge invention', presented within the ICAP framework as 'deep' or 'deepest' understanding, within transformative learning theory as 'enduring transformation', and within Hattie and Donoghue's meta-analyses[50] review as 'deep learning'. Regardless of the learning framework involved, how PSE can incorporate strategies to instil deep motivation to learn involves linking learning to health outcomes and clear articulation of the markers of learning success.

Linking learning to health outcomes: The search for deeper understanding of how we can promote better outcomes for people with chronic pain has recently turned to those consumers

who have recovered, so as to learn from them about what they perceive has most helped them improve.[24,25,28] Two consistent messages to emerge from this work are 'learning that learning helps' and that 'education is an effective intervention'. This has led to the inclusion of 'learn more about your pain' as a key objective of the public pain education offered by such initiatives as Pain Revolution (www.painrevolution.org) and Flippin' Pain (www.flippinpain.co.uk). One might predict that strategies to reinforce these ideas, for example through generic and consistent messaging around learning as a pathway to better health, and a broad focus on pain and health literacy across clinical pathways, should help link learning to health outcomes. Slogans such as 'Learn to live' and 'Know pain. Know gain' may provide opportunities for health care professionals to nudge patients towards seeking understanding as part of their health care management. This would be consistent with a core principle of evidence-based medicine – to equip patients with the understanding required to make optimal decisions about their health care[75], which in turn aligns with the 'shared decision making' approach endorsed by several national health providers[e.g.76].

Articulating criteria for success: Perhaps the most impactful *simple* strategy to optimise motivation to learn is accurate and clear articulation of the criteria for success. In Hattie and Donoghue's[50] synthesis of meta-analyses, clear presentation of success criteria had the biggest single impact of any strategy aimed at instilling deep motivation to learn (Effect size from 13,300 participants =1.13). *Identifying* learning success criteria is described in *Explain Pain Supercharged*[41] as a key component of developing PSE curricula that can be applied across contexts. Articulating criteria for success *appears* similar to goal-setting, but contrasts with it insofar as it is a clinician generated signpost by which the learner can gauge their performance without first knowing the material to be learnt. That said, success criteria can be easily tailored for individuals and can be related to their context and social environment. Table 5 provides examples of articulating learning success criteria, which can be integrated into PSE both conversationally, but also within print, digital or social media resources.

INSERT TABLE 5 ABOUT HERE

Practical implementation, easy wins and easy mistakes

A recent mixed-methods systematic review yielded recommendations for PSE implementation in clinical settings[17]. First, a comprehensive assessment that allows the patient to tell their own story is likely to validate the patient's experience, allow the clinician to identify the patient's prior understanding and beliefs, and integrate Socratic questioning within it. It also allows the clinician to identify those concepts that may be most important, and content that may be most suitable for *that* patient at *that* time and in *that* context (for example, which 'nuggets'[41], 'yarns'[47], metaphors[77,78] or consolidatory behavioural experiments might suit best). Such assessment can also be useful in creating dissatisfaction, where indicated, with a single-cause biomedical view of pain, while not invalidating the learner's experience or situation. It can also demonstrate the clinician's understanding of pain as a coming together of many factors, planting awareness of the biopsychosocial nature of pain and promoting readiness to engage with an educational intervention[17].

Another learning from Watson et al's systematic review[17] is the potential importance of the clinician's teaching expertise in PSE. This is very important within the context of PSE because although increasing a patient's understanding of their health problem – increasing their health literacy – is often considered a core component of care[79–81], it is seldom considered a core capability or skillset of the clinician[79]. The growing evidence that adopting

a new and scientifically-based understanding of one's chronic pain condition is a potentially powerful facilitator of decreasing its impact[e.g.20], seems a compelling reason for us to dedicate more time and effort to gaining these clinical skills. The current review, and the work of the PETAL Collaboration more broadly, reflects this line of thinking.

Diverting our clinical objectives from PNE's 'delivery of pain information' to PSE's 'learning a new way to understand one's condition' began several years ago. More recent resources reflect this. For example, recent adaptations of the *Explain Pain Handbook: Protectometer*[82] for use in clinical trials[e.g.37] has focussed initially on 'learning how to learn', before progressing to pain science content. Patients are first introduced to strategies they can use, and that the clinician can integrate, across their treatment components, to optimise learning and these learning strategies are further developed and consolidated throughout. The 'skill', 'will' and 'thrill' components outlined by Hattie and Donoghue[50] are captured as 'tactics', 'insight' and 'energy'. Full discussion of the resource development associated with PSE's emergence is beyond the scope of the current review, but there are several easily implemented strategies that can be incorporated for 'easy wins' and for avoiding 'easy mistakes' (Table 6).

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Summary/conclusion

The evolution of didactic PNE to its current form, referred to here as PSE, has seen significant influence from established theoretical and empirical research primarily from education science, which provides a massive knowledge base. The dominant underlying models of PSE are self-regulated constructivist models. The learning frameworks that can most readily be applied to designing and further developing PSE are the ICAP Framework, Transformative Learning Theory and the DMCC. Each offers unique utility but there are significant overlaps. There are a range of strategies that clinicians can employ to boost the likelihood of patients undergoing sufficient conceptual change to align their understanding of their pain with contemporary scientific thought. These strategies range from 'easy wins' and avoiding 'easy mistakes', to incorporating recognition of, and tuition in, learning itself as a core component of the intervention. Finally, two practical recommendations appear warranted: that researchers and clinicians recognise the distinction between PNE and PSE and accurately label what it is they are doing; and that clinician competency in PSE, and in patient education more broadly, be a priority objective in the pursuit of better outcomes for people with, or at risk of, persistent pain.

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