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Learning to Read "Quantum": Pseudoscientific Appropriation of Quantum Vocabulary and the Case for Boundary Work in Science Education

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Abstract: Quantum physics has entered the secondary curricula of many countries, and quantum technologies attract unprecedented public investment. In the same period, "quantum" has become one of the most productive vocabularies for pseudoscientific claims, yet the two developments are discussed by different communities. This paper argues that quantum education should teach the boundary between legitimate and usurped uses of quantum vocabulary. I make three claims: the appropriation has a stable, teachable structure; the "mysterious quantum" framing that communicators use supplies the resource that appropriation exploits; and identifying a misused term is not the same as making a nature-of-science judgement.

Keywords: Quantum physics education; pseudoscience; nature of science; science communication; demarcation.

1. Introduction

Quantum physics has moved from the periphery of physics education toward its centre. Fifteen national curricula now include quantum topics, with a shared core covering energy levels, light–matter interaction, wave–particle duality, technical applications, the uncertainty principle, and the probabilistic nature of the theory [1]; international programmes, assessment instruments, and teacher professional development workshops have followed [2].

A second development has received far less attention. "Quantum" has become one of the most productive vocabularies for claims that are not science at all. In 2018, Xinhua News Agency found more than a hundred "quantum" household products on Chinese e-commerce platforms; the most expensive, marketing a "60-core quantum chip", cost 16,800 yuan and claimed to eliminate breast hyperplasia and uterine cysts [19]. In 2021, the China Consumers Association warned that such products are pseudo-technology [20]. In 2019, a "quantum speed reading" course claimed children could read a 100,000-character book in one to five minutes by flipping its pages, at a reported cost of up to 260,000 yuan [21]. In 2026, a Hunan market supervision bureau fined a therapy shop for promoting a "quantum light-wave cardio-cerebral instrument" to elderly customers as a treatment for thrombosis, cervical spondylosis, hypertension, and nodules [22].

These two developments are discussed separately, and the separation is a mistake. The boundary between legitimate and usurped uses of quantum vocabulary is what quantum education is well placed to teach — and currently does not.

2. The Appropriation of Quantum Vocabulary

2.1. Three forms

Three forms may be distinguished. The first attaches "quantum" to material objects — cups, mattresses, insoles, bracelets, patches — claimed to act on the body. The second attaches it to health and medicine: "quantum detection", "quantum healing", and "quantum DNA repair", offered through clinics and detection devices, frequently as a substitute for medical treatment. The third attaches it to spiritual or existential concerns: "quantum energy fields", "cosmic energy", and "quantum hypnosis", sold through personal-development courses and divination services.

The three differ in what is promised — a product's effect, a cure, or a transformation of fortune — and in the regulatory response they attract. What they share is a single feature: a genuine term from physics transferred to a domain of human life and made to carry an extraordinary promise.

2.2. A stable sequence

The sequence by which this transfer is accomplished is regular enough to be taught. Official debunking material identifies three techniques — grafting terms onto ordinary goods, fabricating authority, and inventing testimonials [21]. Expanded:

The first step is **terminological transfer**: genuine terms such as "quantum", "entanglement", and "superposition" are lifted from textbooks and attached to objects with no relationship to them. The second is **semantic substitution**: the referent is quietly changed. The linguistic conditions have been analysed — quantum concepts are abstract enough to require figurative expression, and certain terms proved especially adaptable to refiguration [5]. "Quantum entanglement" denotes a correlation between microscopic systems; in the sales text it becomes a relationship between blood relatives, emotions, or minds, and official material records a paper claiming it could account for the mutual healing of first-degree relatives, which specialists called an irresponsible abuse of quantum theory [21]. Third comes **fabricated authority**: invented certification bodies, claimed university collaborations, white coats, and English-language certificates. Fourth is **narrative substitution**: case stories replace verifiable records, with natural recovery or placebo response attributed to the product. Fifth is **refusal to quantify**: only "improvement" and "regulation", since quantification would expose the claim. Sixth, decisive for teaching, is **refusal of falsification**: challenges are met with "this is science at a higher dimension, you cannot see it" or "effects vary between individuals", formulations no possible

observation could contradict [21].

2.3. An illustrative enforcement case

An administrative case is useful for teaching because its facts have been reviewed. The operator above claimed the device could treat four distinct conditions, supported the claim with fabricated customer experiences, and was found to have engaged in false commercial publicity [22] — the full sequence in compressed form.

Cases of the third form show the sequence at organisational scale. Investigations of personal-development courses in China document training in closed hotel venues with recording prohibited and "quantum testing" packages said to predict misfortunes, priced in the tens of thousands of yuan [23]. Participation levels were sold at escalating prices and members recruited as downstream promoters — a pattern industry studies of divination services describe as general [24]. What begins as a claim about physics ends as an organisational form.

2.4. Distinguishing appropriation from hype

Precision matters, because collapsing two different phenomena weakens the pedagogical response. Nagato distinguishes hype — speaking too optimistically about a technology's feasibility or timeline while still resting on some degree of evidence — from pseudoscience, which is not evidence-based at all [6]. Analyses of quantum coverage support the distinction: in 192 online news stories from major United States outlets, roughly 16 per cent were judged exaggerated, more than three-quarters omitted risks, and close to 70 per cent omitted the uncertain nature of the science [7].

Hype calls for calibration: realistic timelines, explicit uncertainty, acknowledgement of risk. Appropriation calls for demarcation: an account of what makes a claim scientific at all. A curriculum that treats both as "exaggeration" will teach neither.

3. Why the Quantum Domain Is Vulnerable, And Why It Is Instructive

3.1. Three features that invite appropriation

The vocabulary is abstract and counterintuitive. Quantum education research has long documented students' conceptual difficulties. A public that hears the vocabulary without access to the formalism has no independent means of checking its use.

Interpretive questions remain open within physics. Granting consciousness a physical role in measurement has been criticised on technical grounds, including the argument that decoherence and unitary evolution already account for the measurement process without such a role [4]; yet the attribution of mystical powers to quantum reality continues to be advanced as a scientific position. Sociological analysis of the Chinese case identifies the exploitation of exactly these conditions — high cognitive entry, unresolved interpretation, and the public image of scientific authority — as the basis of pseudoscientific transmission [25].

Genuine applications exist. Quantum communication, computing, and metrology are real fields with real public investment. Authentic quantum technology is what makes the appropriation credible: the vocabulary is not invented, only displaced.

3.2. Why the existing framing supplies the resource

Content analyses consistently find that popular accounts frame quantum science as enigmatic: about a quarter of 501 TEDx talks did so [16]; in 385 Dutch newspaper articles, quantum technology was regularly presented as both beneficial and enigmatic [17]; and an analysis of 816 Dutch newspaper articles identified 331 explicit metaphors, systematically linking concepts to source domains [18].

The proposal I wish to advance is this: the framing that communicators use to generate interest supplies the rhetorical resource that appropriation exploits. To present quantum theory as fundamentally mysterious tells an audience that this vocabulary refers to something beyond ordinary comprehension — a short step from there to "anything said about it cannot be checked". The claim is not that popularisation causes pseudoscience; the evidence does not support that. It is that the pedagogical and the appropriating strategies share a resource. Vermaas makes a related point: public debate about quantum technologies presupposes that stakeholders understand them reasonably, and framing the theory as enigmatic obstructs this [15].

3.3. Why the quantum domain is an unusually good teaching context

Science education has long taught the nature of science through demarcation contexts — astrology-based interventions, for instance, expose students' existing ideas [8] — yet Karaman's survey of 780 teachers found many conceptions still within a logical positivist framework [10]. Quantum pseudoscience suits this tradition because the vocabulary is genuine and current, the science is taught in the same curriculum, and the gap between what is claimed and what is measurable is unusually stark.

4. What Quantum Education Currently Does, And Does Not Do

4.1. The boundary question is largely absent from curricula

The fifteen-country curriculum analysis shows that the shared core is technical: interpretive and epistemological aspects of quantum physics — precisely the territory on which demarcation depends — appear in only a few countries, despite research suggesting they help students comprehend novel concepts [1]. Expert views lack consensus on foundational and contested aspects [9], and the mathematics barrier constrains who can be reached at all [2]. Students learn what quantum theory says, stripped of the apparatus that would let them assess what is said in its name elsewhere.

4.2. The problem is measurable, and it is not confined to students

Using a 21-item instrument developed for the purpose, Sciarretta and colleagues measured pseudoscientific beliefs about quantum mechanics in 1,119 secondary students and 125 teachers. Endorsement depended, for students, on trust in public and science institutions, content consumption, school type, and quantum literacy; for teachers, on degree type, quantum literacy, perceived usefulness of teaching the subject, and confidence in teaching it. The authors recommend incorporating nature-of-science elements into both outreach and teacher training [11].

Two features deserve emphasis. The phenomenon is general enough to be treated as a curriculum object rather than an anecdote. And teachers' beliefs are predicted by pedagogical variables — perceived usefulness and confidence — not only by subject knowledge, locating part of the remedy in teacher education.

4.3. Identifying a misused term is not a nature-of-science judgement

The sharpest evidence on what teaching must accomplish comes from a study in which 28 pre-service physics teachers evaluated a pseudoscientific text about quantum healing in a classroom-like vignette, responding as if addressing a student. Most identified the scientific inaccuracies and the misuse of technical terms; only a proportion applied broader nature-of-science critiques. The authors conclude that emphasising nature-of-science principles would improve their capacity for comprehensive judgement [12].

This defines the pedagogical target with unusual clarity. Detecting a misused term is a vocabulary-level operation, within reach of anyone with subject knowledge. Judging whether a claim could be tested is a different operation, not acquired as a by-product of learning physics.

4.4. An adjacent effort exists, but not in the quantum domain

Two recent contributions approach this proposal from neighbouring positions. Webersen and Riese combine nature-of-science principles, identification of science-denial techniques, and heuristics for evaluating supposedly scientific information [13]. Su reports a design-based intervention in which 55 Chinese university students produced animations debunking pseudoscientific claims [3]. Neither is quantum-specific: the first offers a general physics strategy, the second uses pseudoscience for media production. The domain-specific argument — that quantum vocabulary has a characteristic structure of appropriation, and that quantum curricula therefore have a distinctive obligation — has not been made.

5. Implications for Teaching

5.1. Make boundary work an explicit objective, and prepare teachers for it

If judging whether a claim is testable is a distinct competence from recognising a misused term [12], it must be taught as a distinct objective, with its own content and assessment. In a quantum course this need not displace technical content; it requires perhaps two to four hours, attached to existing units rather than added as a separate module.

Teachers' endorsement of pseudoscientific beliefs about quantum mechanics depends on degree type, quantum literacy, perceived usefulness of teaching the subject, and confidence in teaching it [11]. Two of the four predictors are pedagogical, so strengthening teachers' confidence and sense of relevance may reduce credulity independently of physics knowledge — a hypothesis awaiting test, but one with immediate implications for professional development design. Existing models producing measurable gains in teachers' self-efficacy for quantum topics [2] provide a delivery vehicle.

5.2. Teach a three-way distinction, not a binary one

A binary division between science and pseudoscience is both philosophically untenable and pedagogically harmful. Boudry's account of pseudoscience as mimicry is instructive because it is diagnostic rather than definitional [14]: what matters is not a criterion sorting all cases, but the strategies by which an impression of warrant is manufactured. Three categories are more useful than two. Some claims are supported by rigorous evidence. Some are contested but researchable, and the honest position is that they are undetermined. Some are constructed so that no observation could count against them.

The middle category is not a concession; it is what prevents the third from collapsing. A student taught to say "not confirmed" about a contested therapy is better equipped to say "unfalsifiable" next time. Conversely, presenting all non-mainstream claims as fraud pushes students toward over-scepticism, which is not the same competence as demarcation.

5.3. Build the curriculum around the structure of appropriation

Because the sequence in Section 2.2 is stable, it can be taught directly. Each step corresponds to an operation the student can perform: verifying what a term denotes in physics; locating where the referent is changed; verifying whether a claimed authority exists; asking for the source material behind a testimonial; requesting a measurable index and a reference value; and asking whether any possible observation could refute the claim. The last operation is the destination, and it distinguishes boundary work from fact-checking.

The Chinese case material is useful because it is documented and encountered outside the classroom. It also allows a step beyond individual discernment: the third form of appropriation ends as an organisational structure with tiered membership and recruitment of downstream promoters [24], moving the exercise from consumer protection toward group psychology.

6. Conclusion

Quantum physics is entering school curricula at scale, quantum technologies attract unprecedented public investment, and "quantum" has become one of the most exploited vocabularies in the pseudoscience marketplace. These facts are usually discussed separately; this paper argues that the third belongs in the curriculum alongside the first. It rests on four claims: that the appropriation has a stable, teachable structure; that the enigmatic framing popular communication uses supplies the resource that appropriation exploits; that pseudoscientific beliefs about quantum mechanics are measurable and present among teachers as well as students; and that recognising a misused term differs from judging whether a claim is testable.

The intervention proposed here has not been implemented or evaluated. The next steps are a taught unit with pre- and post-measurement using an instrument already validated for pseudoscientific beliefs about quantum mechanics [11], and a comparative study of whether the appropriation structure is stable across language communities — a question that matters because appropriation is not primarily a physics problem, but one of institutions, authority, and group psychology.

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