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Animating Concepts In Chemistry Through Story-Telling Narrative Approach

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Abstract

Teaching Chemistry often encounters challenges , because of its abstract nature. It is abstract because of its core concepts with its conventional emphasis are full of symbolic and mathematical representations. My article focusses on the narrative storytelling strategy for students to have a better conceptual understanding and enhanced engagement with the subject Chemistry.

By narrating the genesis of the discoveries of Scientists like as Archimedes, Amedeo Avogadro, Michael Faraday, August Kekulé, Louis Pasteur, Max Plank , Louis de Broglie, and Charles Friedel–James Crafts , one can humanise the scientific principles without compromising on rigour. This article proposes a structured framework for teaching chemistry at undergraduate and postgraduate levels. The approach emphasises curiosity-driven learning, improves conceptual clarity, and retention. Thus the storytelling mode can synergise conventional and modern novel teaching methodologies.

Keywords

Chemistry education; Storytelling Methodology; History of chemistry; Conceptual learning; Scientific discovery; Active Interactive rather proactive learning

1. Introduction

Chemistry always occupies a unique position in science education in connecting the observable/ invisible and translating everyday phenomena into molecular interactions and mathematical relationships. Hence, many students perceive chemistry as difficult and abstract. This is mainly due to the way of teaching through formulas, definitions, and problem-solving routines in a mechanical way However, if one deals with the genesis, with actual factual illustrations ,the background and the relevant context, then it will become very lively and vivid.

The development of chemistry was from solving concrete problems It evolved from careful observations and the logical rationale of scientists attempting to understand the natural world.

My article deals with integrating **historically accurate narratives** into chemistry teaching, whereby, the students shall have improved association with subject and comprehensive grasp of the concepts.

By presenting discoveries as intellectual journeys rather than isolated experiments and results, Professors and educators can align their teaching practices with the natural processes of scientific inquiry. It will surely kindle the latent talent in each.

2. Storytelling as a novel technique / Amazing Awakening Tool

Storytelling, in an academically engaging method, but does not imply fictionalisation; rather, it's a novel, structured presentation of information in a narrative form. The narrative pattern surely enhances the learning by:

- Providing logical sequencing of ideas
- Make way for linking the prior knowledge and new concepts
- Engaging attention through causality and resolution with enhanced kindled interest.

It helps the audience understand and remember the basic concept leaving an evergreen impression in the minds of the blooming scholars .

3. Narrating the Genesis of Discovery in Chemistry

3.1 Observation Leading to Principle: Archimedes

Once, the King of Sicily (now in ITALY) asked Archimedes to determine the purity of the gold in the Royal crown made by the palace goldsmith without damaging it. **W**hile bathing , Archimedes realised that the weight (Density of water is one (one gram per CC)) of water displaced is equal to his own weight when he is fully immersed in water. Density reflects purity. Hence, Archimedes could easily determine the density of the gold crown and its purity. He became so excited about this investigation of the purity of GOLD in a royal crown, he was so excited that he started running out of the bathroom naked shouting " Eureka, Eureka".

Thus, this led to the enunciation of the principle of buoyancy, Law of flotation, etc. His observation of water displacement during bathing provided a method to determine volume indirectly. Concepts such as density and volume measurement become meaningful when introduced as solutions to real problems.

The vital concept emerged >>**When a solid is completely immersed in a liquid, the apparent loss of weight experienced by the solid, is equal to the weight of the liquid displaced by the solid .>>**

3.2 Concept of Mole: Amedeo Avogadro (1811)

Avogadro proposed this vital concept that gaseous systems occupying identical volumes at equivalent temperature and pressure conditions possess proportional molecular populations." This was when atoms were not directly observable, but this hypothesis provided a critical link between macroscopic measurements and microscopic entities. Avogadro observed

- Hydrogen gas is **H_2**, not H ;;Oxygen gas is **O_2**, not O

Now the reaction becomes:$2H_2 + O_2 \rightarrow 2H_2O$ ☞ Suddenly:

Volume ratios match perfectly, Theory and experiment align

The most incredible point is AVOGADRO (1811) could never define the no of moles 6.023 × 10^23, but it was quantified by Cannizzaro in 1860. Avogadro's idea could just resolve the confusion in atomic masses ,It provides consistency in chemical formulas and only then did chemists accept it widely.

Avogadro's contribution lay not in determining the numerical value of molecular populations, but in proposing a conceptual framework that linked the gas volume with particle count. By distinguishing between atoms and molecules, he resolved inconsistencies between Dalton's atomic theory and Gay-Lussac's experimental observations. Although initially overlooked, his hypothesis later became foundational to modern chemical quantification

The emergence of R, the universal gas constant, illustrates how scientific understanding evolves through synthesis rather than isolated discovery.

Empirical observations by Boyle, Charles, and Gay-Lussac established relationships between pressure, volume, and temperature, while Avogadro introduced the crucial link between volume and number of particles.

When these independent insights were unified, the proportionality $PV \propto nT$ required a constant of proportionality, giving rise to the universal gas constant R.

Subsequent thermodynamic analysis by Mayer revealed that this same constant governs the difference between MOLAR heat capacities at constant pressure Cp and Cv, MOLAR heat capacities at constant volume, linking macroscopic measurements with energetic considerations.

Relation Between **Cp and Cp** (Ideal Gas)

For an ideal gas: $Cp-Cv=R$

This is called **Mayer's relation**.

Julius Robert Mayer (1840s)

Physical Meaning (Very Important for Teaching)

- Cv: heat required at constant volume
- Cp: heat required at constant pressure

At constant pressure, gas expands → does work, so extra heat is needed

That extra amount = **R, The important interpretation,** $Cp=Cv+R$

Boltzmann later established the important molecular-scale behaviour through the relation R= Na X Kb

(R… Universal Gas constant; Na...Avogadro number .Kb.. Boltzmann Constant)

This is a sensational demonstration that the macroscopic gas behaviour is ultimately rooted in microscopic particle dynamics.

From Avogadro to Boltzmann, the gas constant R acts as a bridge—from counting particles to measuring energy."

Further more MAX PLANK introduced quantisation of energy. This, coupled with the Boltzmann Constant, has paved the way to prove that the energy, temperature and probability are deeply connected.

3.3 Michael Faraday. Father of Modern Electrifying Civilisation

Faraday's work in electromagnetism is extraordinary. It's a classic case of methodical, systematic experimentation. His investigations were guided by observation and iterative refinement rather than formal theoretical training. Hailing from a very poor family, the son of a blacksmith worked in a book-binding shop. Studied numerous books, while binding them, but never had a formal school education. Humphrey Davy took him as his assistant.

Faraday observed that electric current can deflect a magnetic compass needle and further believed that when electricity creates magnetism, then the magnetism can also create electricity. He further believed that NATURE possessed UNITY. A stationary magnet does not generate electricity, but when it's moved, current is generated. It was a great experimental curiosity. Faraday proved that a scientific genius can emerge from humble origins. He entered science through a book-binding shop, and his curiosity eventually electrified and illuminated the Modern world

3.4 Benzene's Structural Innovation: August Kekulé

Kekulé's proposal of the cyclic structure of benzene marked a turning point in organic chemistry. While often associated with a dream narrative, the structural model was grounded in extensive experimental evidence and theoretical reasoning.

The formula C6H6, for nearly six carbon atoms, has just six hydrogen atoms; it is surely very unsaturated and is expected to be very reactive. But it is highly stable and resists additions, but behaves like alkenes. It was a real challenge to elucidate the nature of bonding, and benzene refuses to fit into a linear structure.

One spark of imagination became famous when, in a fireplace, a snake seizing its own tail, forming a hexagonal ring, resulted in a rare and radical possibility forming the basis of AROMATICITY. (cyclic structure of six carbon hydrogen alternating single double bond closed ring) All great grand concepts of resonance, Conjugation, Delocalisation, Pi-bond cloud, Hückel criteria, etc., emerged as inevitable implicit imperatives and are the most sensational outcomes. Scientific models evolve through both imagination and validation. The modern organic chemistry began to acquire architectural sophistication through the Benzene ring, esp dyes, polymers, pharmaceuticals, explosives and petrochemicals

3.5 Chemistry and Society: Louis Pasteur

Pasteur's work on fermentation and microbial processes demonstrated the practical applications of chemistry in health and industry. His findings led to the development of pasteurisation, significantly improving food safety.

Relating chemistry to societal impact enhances relevance and motivation.

Microorganisms were active agents causing chemical changes in MILK Wine etc He started heating the MILK in a controlled manner and rapidly cooling it, whereby killing many harmful microorganisms and preserving Taste and quality. This process is called PASTEURISATION, a controlled thermal treatment, a major food preservation technique to ensure dairy safety and public hygiene. Numerous lives were protected. Thus, chemistry moved from the lab directly to Public health, proving that such discoveries emerge from practical societal problems and influence everyday life. By linking microbes to chemical transformations, Pasteur changed Public life, and his discovery radiates into multiple disciplines, such as thermal stability, sterilisation chemistry, food technology, biochemical fermentation, and kinetics of microbial destruction.

3.6 Quantum Theory: Max Planck

Planck's introduction of quantized energy marked the beginning of quantum theory. His work addressed inconsistencies in classical physics and opened new directions in scientific thought.

When objects are heated they glow red, orange , and then white how energy is distributed across different wavelength . the black body radiation problem .The then existing theories (classical Physics) could not fully explain this ULTRA VIOLET CATASTROPHE .

The nature did not behave the way as to supply infinite level of energy .Thus energy is not emitted continuously but released in tiny discrete pockets QUANTA.

However Max plank did not readily claim energy existe in packets and though he discovered quantum theory , he was trying to avoid it . He was a deeply conservative scientist and admired classical physics . He was very reluctant to seek revolution until Einstein endorsed his views . Einstein enunciated , in photochemistry , even light is cluster of tiny pockets of energy Quantised E = h v

The planks constant h is a great grand sensational break through in modern quantum chemistry . it could then settle the mathematical challenge posed by classical physicist .

Scientific advancement often arises from addressing limitations of existing theories

3.7 Wave–Particle Duality: Louis de Broglie

De Broglie extended wave concepts to matter, proposing that particles exhibit wave-like properties. This idea was later confirmed experimentally and became fundamental to quantum mechanics.

If matter was particulate , and energy was continuous . but Max plank Einstein have proved mathematically that energy is not continuous but emitted in discrete packets called quanta .

Young princess Louis de Broglie came out with one of the boldest idea , if waves can behave like particles , why not particles (MATTER) behave like waves ;He further proposed that every moving particle has a wave character λ= h / p

λ = Wave length ; h = Planks constant ; p =momentum

Encouraging hypothesis-based thinking helps students grasp abstract theories.

Thus **h** the planks constant became the bridge Planck's constant became the bridge between particle and wave descriptions.

Each scientist extended the previous idea IN A LOGICAL GRACEFUL MANNER :

Planck ……. Energy becomes granular.
Einstein…… Light behaves like particles.
De Broglie …… Matter behaves like waves.
Schrödinger …. Matter waves obey mathematical laws.
Planck fractured the continuity of energy, de Broglie gave matter a wave-like identity, and Schrödinger transformed that strange intuition into the mathematics of the atom."

Quantum mechanics emerged not from certainty, but from scientists reluctantly accepting increasingly unbelievable truths.

Without this sequence , today there would be

- no atomic orbitals,
- no bonding theory,
- no molecular spectroscopy,
- no quantum chemistry,
- no modern understanding of reactivity.

Thus the modern chemistry stands upon the intellectual bridge connecting Planck, Einstein , De Broglie and Schrödinger.

3.8 Reaction Mechanisms: Charles Friedel and James Crafts

The Friedel–Crafts reactions introduced systematic methods for forming carbon–carbon bonds, linked to the benzene ring contributing significantly to synthetic organic chemistry.

Benzene with its pi bond cloud , is found to be suborn, stable , very resistant molecule .But the chemist could easily perform electrophilic substitutions readily using hetero atoms namely Nitration, Sulphonation, and Halogenation . This was possible due to the powerful electrophiles attacking the electron rich benzene ring

However , attaching a carbon containing group required a stable carbon electrophile , which was a major challenge Ordinary alkyl halide were not adequately reactive to actuate benzene effectively to add another carbon atom while keeping aromaticity intact .Here came genius of Friedel Crafts , who used the anhydrous $AlCl_3$ a great catalyst which could activate alkyl or acyl halides to generate a electrophilic spiecies to attack the electron rich benzene ring . This has opened up the flood gates of synthesis of numerous aromatic molecules which was a revolutionary step

Thus Friedel–Crafts chemistry represented:the transition from aromatic modification to aromatic construction.

"Chemists had learned to decorate the benzene ring with hetero atoms, but Friedel and Crafts taught them how to extend its carbon skeleton."

"Introducing chlorine or nitro groups altered benzene's personality; introducing carbon groups altered its architecture."

Friedel crafts showed the world the following major highghts

Why electrophilic aromatic substitution evolved gradually?

- why catalysts became necessary,
- and why carbon–carbon bond formation is treated specially in synthesis.

Hetero atom electrophiles are often intrinsically electron-deficient.

Carbon electrophiles are less naturally stable, more rearrangement-prone, and harder to control.

Thus Fridel–Crafts chemistry also introduced:carbocation chemistry, rearrangements, and mechanistic organic thinking.

4. Framework for Implementation in Chemistry Teaching

A structured storytelling approach can be implemented as follows:

1. **Contextual Introduction** – Present the historical problem
2. **Conceptual Gap** – Identify limitations in existing knowledge
3. **Scientific Contribution** – Introduce the discovery
4. **Concept Integration** – Link to theoretical principles
5. **Application** – Demonstrate practical relevance
6. **Student Engagement** – Encourage discussion and reinterpretation

5. Role of Engagement without Compromising Accuracy

Engagement in teaching does not require fictionalization. Instead, it can be achieved through:

- Clear and vivid descriptions
- Logical sequencing of events
- Occasional light humour grounded in context
- Emphasis on human effort and reasoning

Such an approach maintains academic integrity while enhancing readability.

6. Implications for Higher Education

In advanced chemistry education, storytelling can:

- Facilitate understanding of complex theories
- Encourage analytical and critical thinking
- Support interdisciplinary connections

For postgraduate students, narratives can extend to research case studies, experimental design, and scientific debates.

7. Conclusion

Chemistry is fundamentally a human endeavour shaped by observation, reasoning, and creativity. Presenting it through historically accurate narratives allows students to engage with the subject more deeply and meaningfully. Storytelling, when used responsibly, does not dilute scientific rigor; rather, it strengthens understanding by situating knowledge within its intellectual context. It draws students to get engrossed into the subject and turn them more inspired and enthusiastic.

References (APA Style)

1. Allchin, D. (2014). From science studies to scientific literacy. *Science & Education*, 23(9), 1911–1932.
2. Bruner, J. (1991). The narrative construction of reality. *Critical Inquiry*, 18(1), 1–21.
3. Brock, W. H. (1993). *The Norton History of Chemistry*. Norton.
4. Jensen, W. B. (2000). Logic, history, and the chemistry textbook. *Journal of Chemical Education*, 77(6), 817–822.
5. Matthews, M. R. (2015). *Science Teaching*. Routledge.
6. Holton, G. (1978). *The Scientific Imagination*. Harvard University Press.
7. Nye, M. J. (1993). *From Chemical Philosophy to Theoretical Chemistry*. University of California Press.
8. Kind, V. (2009). Pedagogical content knowledge. *Studies in Science Education*, 45(2), 169–204.
9. Schank, R. C., & Abelson, R. (1995). Knowledge and memory. *Advances in Social Cognition*, 8.
10. Tobin, K. (2012). *Constructivism and Teaching Science*. Sense Publishers.S