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From cosmic reorientation to scientific culture: Reinterpreting the scientific revolution through historical analysis and functional modelling

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ABSTRACT

Between the sixteenth and eighteenth centuries, European approaches to nature were reorganised through mathematical astronomy, instrument-based observation, experiment, and new expectations about evidence. This article revisits that transformation without treating it as an instantaneous victory of modern reason over a uniformly medieval past. Instead, it interprets the Scientific Revolution as a layered process in which inherited philosophies, religious commitments, artisanal skill, print culture, patronage, commerce, and scholarly exchange interacted with changing scientific practices. The study combines historical analysis and source systematisation with IDEF0 functional modelling. The first model explains how varied primary and secondary materials can be converted into a coherent yet qualified historical interpretation through source mapping, contextualisation, critical evaluation, and synthesis. The second model shows how that interpretation can be translated into contemporary education through curriculum integration, interdisciplinary teaching, source-based inquiry, and connections to present scientific and ethical questions. The analysis indicates that the period changed more than particular theories: it altered how credible knowledge was produced, communicated, tested, and authorised. IDEF0 makes the analytical and educational sequence visible, but it is used as a heuristic framework rather than as a causal explanation of historical change. The study is limited by its predominantly European focus and by the conceptual, rather than classroom-tested, character of the models. Future research should broaden the geographical frame, develop digital and museum-based applications, and evaluate the educational model with learners and teachers.

KEYWORDS: Scientific Revolution, early modern science, history of science, worldview, IDEF0, functional modelling, science education

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1. Introduction

When Nicolaus Copernicus published his sun-centred arrangement of the heavens in 1543, Europe did not wake the next morning inside a new intellectual world. The older geocentric universe remained deeply embedded in education, theology, everyday language, and astronomical practice. What followed was a prolonged period of argument in which mathematical models, observations, instruments, philosophical assumptions, and institutional interests were repeatedly tested against one another. The expression "Scientific Revolution" therefore names a large historical reorganisation rather than a single event or a smooth march from error to truth (Copernicus, 1978; Cohen, 1994; Westman, 2011).

The conventional chronology extends from the sixteenth century into the early eighteenth century, although its boundaries remain open to debate. Within that flexible frame, astronomy was decisively reconstructed; motion was expressed in new mathematical forms; experiment acquired greater authority; anatomical and medical investigation became more closely tied to observation; and instruments enlarged the range of phenomena that could be seen, measured, and discussed. These developments did not all occur together, nor did they arise from one method. Their cumulative effect was to change the terms on which claims about nature could be accepted (Daston & Park, 1998; Gaukroger, 2006; Koyré, 1957).

The best-known names still matter. Copernicus displaced the Earth from the geometric centre of the planetary system; Johannes Kepler replaced perfect circular paths with mathematically specified ellipses; Galileo Galilei used telescopic observations to disturb inherited pictures of an unchanging heaven; Francis Bacon argued for disciplined inquiry grounded in organised experience; and Isaac Newton brought terrestrial and celestial motion within a common mathematical framework (Bacon, 2000; Galilei, 1989; Kepler, 1992; Newton, 1999). Yet a history composed only of celebrated individuals is incomplete. The transformation also depended on printers, navigators, physicians, artisans, instrument makers, translators, patrons, teachers, and communities that preserved, disputed, or circulated knowledge.

The period matters because it reshaped the relationship between knowledge and authority. Demonstration, replication, measurement, calculation, and publicly examinable evidence gradually became more important, even while theology, classical learning, courtly power, and established institutions continued to influence the questions that could be asked. The change was not a simple removal of belief from science. It was a renegotiation of intellectual boundaries, social credibility, and the practices by which knowledge acquired legitimacy (Biagioli, 1993; Harrison, 2015).

1.1. Why the subject still matters

Studying the Scientific Revolution is valuable for more than locating the origins of modern physics. It shows that scientific knowledge is made through uncertainty, disagreement, revision, and collaboration. Students who encounter only finished laws and polished textbook summaries can easily imagine that science advances through isolated moments of genius. Historical cases reveal a more demanding process: evidence is interpreted, instruments have limitations, theories compete, social institutions distribute credibility, and even successful explanations remain open to refinement.

That historical perspective supports critical thinking. Copernican astronomy, telescopic evidence, and Newtonian synthesis demonstrate that questioning an inherited framework requires more than courage. A challenger must assemble a persuasive relation among observation, calculation, explanation, and communication. The history therefore offers a practical lesson in how new ideas overcome resistance and also in why resistance is not always irrational. Established frameworks may organise large bodies of experience, and replacing them involves conceptual as well as social work (Kuhn, 1957; Westman, 2011).

The period also opens ethical questions that remain current. Scientific capability can improve human life, but its consequences depend on institutions, access, political priorities, and public judgement. Teaching the history of science alongside present concerns such as climate change, artificial intelligence, biomedical innovation, and environmental risk encourages learners to ask not only whether a claim is technically sound but also how knowledge is communicated, whose interests it serves, and what obligations accompany its use.

Finally, the Scientific Revolution resists narrow disciplinary boundaries. Astronomy drew on geometry, navigation, optics, and instrument making; medicine connected anatomy, trade, collecting, and local knowledge; natural philosophy interacted with art, craft, religion, commerce, and political power. Such interdependence is especially relevant to contemporary problems that cannot be addressed by one field alone (Cook, 2007; Smith, 2004).

1.2. Aim, questions, and organisation

The article has two linked aims. The first is to provide a historically responsible account of the Scientific Revolution as an intellectual, material, social, and cultural transformation. The second is to construct a transparent model for organising that historical knowledge and converting it into educational use. Historical analysis supplies the interpretive depth; IDEF0 functional modelling clarifies the sequence of activities through which sources become an account and an account becomes a learning resource.

Three questions guide the discussion. First, which interacting changes most clearly explain the new worldview associated with the Scientific Revolution? Second, how can diverse historical materials be processed into a coherent interpretation without erasing disagreement or context? Third, how can that interpretation be used to educate modern audiences while avoiding a simplified story of inevitable progress?

The next section reviews the main historiographical and conceptual issues. The methodology section explains the source strategy, historical procedure, and use of IDEF0. The findings then present a historical synthesis, an A0 model for producing a critical account, and a B0 model for educational application. The discussion evaluates the contribution and limitations of the combined framework before the conclusion identifies directions for further study.

2. Historiographical and Conceptual Background

Writing the history of the Scientific Revolution involves a basic tension. The period undeniably produced major changes, yet the word “revolution” can make those changes appear more sudden, unified, and complete than they were. A useful account must preserve the scale of transformation without turning several centuries of uneven development into a single heroic narrative.

2.1. Beyond a single heroic story

Older accounts often organised the period as a sequence of conceptual victories: heliocentrism displaced geocentrism, experiment replaced speculation, and modern science emerged from the defeat of scholastic authority. That structure remains attractive because it is clear and memorable. Its weakness is that it treats past thinkers as successful only when they resemble later scientists and overlooks the persistence of astrology, alchemy, theology, natural magic, and other practices that belonged to early modern attempts to understand nature (Cohen, 1994; Daston & Park, 1998).

A broader historiography shifts attention from isolated discoveries to practices and settings. Knowledge was produced at courts, universities, workshops, observatories, ships, anatomical theatres, gardens, libraries, and commercial centres. Patronage could fund investigation while shaping its presentation. Artisanal experience could provide techniques unavailable in formal philosophical training. Printed books accelerated circulation, but letters, demonstrations, specimens, and instruments remained essential forms of exchange (Biagioli, 1993; Smith, 2004).

This wider view also corrects a rigid opposition between science and religion. Early modern investigators did not generally understand those domains as modern readers do, and many interpreted the study of nature as compatible with religious purpose. Conflicts occurred, sometimes dramatically, but cooperation, institutional negotiation, and shared intellectual vocabularies were equally important. Treating “science” and “religion” as timeless, self-contained opponents imposes later categories on an earlier world (Harrison, 2015).

2.2. Mathematical astronomy and the reordering of the cosmos

Astronomy provides the clearest line of conceptual change. Copernicus reorganised planetary order around the Sun, yet retained important elements of classical astronomy. His system altered the geometric relationship among the planets and raised difficult questions about terrestrial motion, physical causes, and scriptural interpretation. It was therefore both innovative and dependent on older traditions (Copernicus, 1978; Kuhn, 1957).

Kepler transformed that proposal by treating planetary paths as ellipses and relating their motion to mathematical regularities. Galileo then used the telescope to report mountains on the Moon, satellites around

Jupiter, and a multitude of previously invisible stars. These observations did not mechanically prove one complete cosmology, but they weakened the distinction between a perfect heaven and a changing Earth and demonstrated that instruments could become participants in arguments about reality (Galilei, 1989; Kepler, 1992).

Newtonian mechanics offered a later synthesis. By expressing motion and gravitation mathematically, Newton connected falling bodies, projectiles, tides, planetary orbits, and cometary paths within a common explanatory structure. The achievement did not close scientific inquiry, but it established a powerful expectation that apparently different natural events might be governed by general relations capable of calculation (Newton, 1999).

2.3. Instruments, experiment, and skilled practice

The changing worldview was inseparable from changes in practice. Telescopes and microscopes did not simply reveal nature without mediation; observers had to learn how to use them, judge optical artefacts, compare reports, and persuade others that unfamiliar images were trustworthy. Air pumps, clocks, thermometers, measuring devices, anatomical techniques, and collections similarly reorganised what could count as evidence. The credibility of an observation depended on the device, the observer, the setting, and the community evaluating the report.

Baconian programmes gave philosophical expression to the value of organised experience, cumulative observation, and inquiry directed toward useful knowledge. Actual experimental cultures were more diverse than any single programme, but the growing status of controlled intervention distinguished a major strand of early modern investigation. Knowledge increasingly involved making phenomena appear under specified conditions rather than merely contemplating nature as given (Bacon, 2000; Gaukroger, 2006).

Craft knowledge was central to that change. Metalworkers, painters, lens grinders, navigators, surveyors, apothecaries, and other skilled practitioners understood materials through repeated bodily engagement. The boundary between knowing and making became more permeable as scholars drew upon workshop procedures and artisans made claims about the intellectual value of experience (Smith, 2004).

2.4. Institutions, communication, and the circulation of knowledge

Ideas travelled through infrastructures. Printing enabled diagrams, tables, observations, and disputes to reach wider audiences with greater consistency, although access remained uneven. Correspondence networks allowed scholars to request observations from distant locations, exchange instruments, and test reports. Courts offered patronage and prestige; universities provided continuity and training; academies and learned societies created new routines of demonstration, record keeping, and collective judgement.

Commerce also shaped knowledge. Long-distance trade moved plants, medicines, specimens, maps, measurements, and practical information across regions. Medical and natural-historical knowledge grew through encounters among merchants, physicians, collectors, local experts, and colonial institutions. The circulation was not equal or innocent: appropriation, unequal power, and the loss of contributors' names often accompanied the movement of information (Cook, 2007; Raj, 2007).

These connections reveal a limitation in narratives confined to a self-contained Europe. The major mathematical and institutional developments examined here were concentrated in European settings, but they were supported by wider movements of texts, goods, techniques, and people. A responsible interpretation must therefore distinguish the geographical location of particular innovations from the broader networks that made them possible (Raj, 2007).

2.5. The educational gap

History can make science more intelligible by restoring problems, uncertainty, personality, and social context. Historical narratives can help learners see why an explanation was difficult to formulate and how evidence acquired meaning within a debate. They can also challenge the stereotype of science as a collection of final answers produced by detached geniuses (Clough, 2011; McComas, 2008; Metz et al., 2007).

Implementation, however, is not straightforward. Teachers may lack time, historical preparation, suitable primary-source materials, or confidence in managing philosophical discussion. Poorly designed episodes can become decorative anecdotes that leave the scientific content untouched. Historical complexity can also overwhelm learners when it is not connected to explicit educational aims (Höttecke & Silva, 2011; Matthews, 2014; Monk & Osborne, 1997).

The gap addressed in this article lies between rich historical scholarship and practical educational use. Many studies explain what changed during the Scientific Revolution, while educational research explains why history can support learning. Less attention is given to the transparent chain of operations by which sources are selected, interpreted, converted into a defensible account, and then redesigned as teaching material. Functional modelling is introduced here to make that chain explicit.

3. Methodology

The study uses a qualitative, interpretive design. It does not test a historical hypothesis through statistical data, nor does it claim to provide a systematic review of every publication on early modern science. Its purpose is analytical and constructive: to synthesise representative historical evidence and to model the work required to move from evidence to interpretation and from interpretation to education.

3.1. Source base and selection strategy

The source base combines landmark primary works with modern historical and educational scholarship. The primary group includes selected writings associated with Copernicus, Kepler, Galileo, Bacon, and Newton. These texts were chosen because they illuminate changes in cosmology, mathematical reasoning, observation, method, and physical explanation. They are not treated as a complete canon or as the sole causes of the Scientific Revolution.

The secondary group was selected to represent several interpretive dimensions: the historiography of the Scientific Revolution; intellectual and religious categories; courts and patronage; instruments and craft; medicine, commerce, and collecting; global circulation; and the use of history in science education. Priority was given to scholarship published by established academic presses or peer-reviewed journals, together with the formal specification of IDEF0. Sources devoted exclusively to later scientific periods or to technical subjects with no direct relevance to the analytical questions were not included.

Selection was purposive rather than exhaustive. The resulting corpus supports conceptual breadth and methodological comparison, but it cannot represent every region, scientific field, or historiographical position. That limitation is addressed through cautious claims and by identifying geographical expansion as a central priority for future research.

3.2. Historical analytical procedure

The historical analysis proceeded in four passes. The first identified each source's central claim, evidential basis, key actors, and chronological setting. The second located the claim within relevant social, political, religious, material, and institutional conditions. The third compared interpretations, paying particular attention to disagreement over continuity, rupture, agency, and geographical scope. The fourth synthesised recurring patterns into a small number of analytical dimensions.

Source criticism was applied throughout. Primary works were read as interventions produced for particular audiences rather than as transparent reports of discovery. Secondary works were assessed for scale, emphasis, and explanatory assumptions. This procedure reduces the risk of treating later scientific success as proof that a historical actor's reasoning was obvious or inevitable.

The final historical synthesis was organised around four questions: What changed in the representation of nature? What practices made new claims credible? Which institutions and networks enabled their circulation? How did the transformation alter relations among knowledge, authority, and education? These questions also formed the controls that guided the functional models.

3.3. IDEF0 functional modelling

IDEF0 represents a system through functions and the relations that enable or constrain them. A function is shown as an activity box. Inputs enter the activity and are transformed; controls specify the rules, standards, or conditions governing that transformation; mechanisms identify the people, tools, and resources that perform it; and outputs are the resulting products or information. The method also permits a high-level function to be

decomposed into more detailed activities (National Institute of Standards and Technology, 1993).
The method originated in systems and process analysis, not in historiography. It is used here because it forces the researcher to state what material enters an analytical process, what constrains interpretation, who or what carries out the work, and what outcome is expected. Contemporary applications show that IDEF0 remains useful when complex activities must be made visible and internally consistent (Gibbons & Witherell, 2024).

The model does not imply that history itself behaves like an engineered system. Historical change is contingent, contested, and only partly recoverable. IDEF0 therefore serves as a map of the researcher's and educator's operations, not as a mechanical explanation of why the Scientific Revolution occurred.

3.4. Model construction and analytical safeguards

Two top-level functions were defined. A0 is "construct a critical understanding of the Scientific Revolution from diverse historical evidence." B0 is "convert that understanding into historically grounded education for modern audiences." Each function was decomposed into four activities, and every activity was checked for a clear input, governing control, enabling mechanism, and identifiable output.

Three safeguards guided model construction. First, interpretive qualification had to remain visible; the output could not be described as a single final truth. Second, educational adaptation could simplify presentation but not remove uncertainty, controversy, or source context. Third, movement from A0 to B0 had to be reversible: classroom questions and learner responses should be able to expose omissions and prompt renewed historical analysis.

The models were evaluated conceptually against the historical synthesis and the education literature. No classroom intervention was conducted, and no claim is made that the B0 sequence has yet improved learning outcomes. The models should therefore be understood as transparent, testable proposals for future design and evaluation.

4. Findings

The analysis produced two kinds of result. The first is a revised historical account of what the Scientific Revolution changed. The second is a pair of functional models that organise the production and educational use of that account.

4.1. Historical synthesis: four dimensions of change

The first dimension was cosmic reorientation. Heliocentrism did more than move the Earth. It destabilised the relation between ordinary perception and mathematical explanation, because human observers appeared stationary even if the Earth moved. Kepler's laws and Newtonian mechanics then strengthened the claim that celestial order could be represented through mathematical relations rather than through a hierarchy of qualitatively different realms. The emerging universe was larger, more dynamic, and increasingly open to quantitative description (Copernicus, 1978; Kepler, 1992; Koyré, 1957; Newton, 1999).

The second dimension was the disciplined production of evidence. Observation became more closely connected to instruments, records, comparison, and repeatable procedures. Experiment introduced a deliberate intervention into natural processes. Neither observation nor experiment was entirely new, but their organisation and public role changed. A credible claim increasingly required an account of how the phenomenon had been produced or observed and how others might inspect the result (Bacon, 2000; Gaukroger, 2006).

The third dimension was the social and material expansion of knowledge making. Scholars depended on workshops, courts, ships, markets, collections, and communication networks. Scientific authority was not generated by ideas alone; it was assembled through access to tools, skilled labour, patronage, publication, and communities of judgement. This finding replaces the image of the solitary thinker with a distributed ecology of knowledge (Biagioli, 1993; Cook, 2007; Smith, 2004).

The fourth dimension was the pluralisation of authority. Classical texts and theological commitments did not disappear, but they no longer exhausted the legitimate grounds for natural knowledge. Mathematical coherence, instrument-assisted observation, experiment, and collective scrutiny acquired greater weight. The result was not the end of authority; it was the creation of additional routes through which authority could be earned, challenged, and redistributed (Harrison, 2015).

Table 1. Four dimensions of the reorganisation of natural knowledge

Dimension	Earlier emphasis	Reorganisation during the period	Long-term significance
Cosmos and motion	Earth-centred order and qualitative division between terrestrial and celestial realms	Heliocentric arrangement, elliptical orbits, mathematised motion, and universal gravitation	Nature increasingly represented through general quantitative relations
Evidence	Authority of inherited texts and unaided observation	Instrument-assisted observation, experiment, measurement, records, and comparison	Claims expected to specify how evidence was produced and examined
Knowledge makers	Formal philosophers and learned institutions foregrounded	Greater interaction among scholars, artisans, navigators, physicians, printers, and patrons	Scientific knowledge understood as materially and socially distributed
Authority and communication	Classical, theological, and institutional frameworks dominant	Additional authority gained through calculation, demonstration, publication, and collective scrutiny	Knowledge became more publicly contestable and revisable

4.2. Model A0: From historical evidence to critical interpretation

A0 addresses the problem of constructing a broad yet disciplined understanding of the Scientific Revolution. Its inputs are primary texts, material and visual evidence, archival records, and secondary scholarship. Its controls are the chronological frame, source criticism, historiographical questions, standards of evidence, and the requirement to acknowledge uncertainty. Its mechanisms include historical expertise, libraries and archives, digital databases, translation, and interdisciplinary comparison. Its output is a coherent, documented, and revisable interpretation.

The model is decomposed into four activities. A1, evidence mapping, assembles a deliberately varied body of material and records provenance, date, genre, audience, and relevance. A2, contextualisation, reconstructs the social, political, religious, technical, and institutional conditions that shaped each item. A3, critical interpretation, examines bias, silence, credibility, conceptual vocabulary, and disagreement among sources. A4, synthesis and communication, integrates the results into themes, narratives, diagrams, or teaching-ready case files while preserving the qualifications identified earlier.

The sequence is iterative rather than strictly linear. Contextual analysis can reveal the need for new sources; critical interpretation may alter the initial categories; synthesis may expose an unsupported generalisation. The arrows in the model therefore indicate a principal direction of work, not a rule that one stage must be permanently completed before another begins.

The central gain from A0 is traceability. A reader or collaborator can ask which sources support a thematic claim, which controls limited interpretation, and what resources made the analysis possible. That transparency is especially important when a broad label such as the Scientific Revolution brings together different sciences, regions, institutions, and timescales.

Table 2. Context definition for the A0 historical-analysis function

IDEF0 element	A0 specification
Function	Construct a critical understanding of the Scientific Revolution from diverse historical evidence.
Inputs	Primary works; archival records; instruments and images; material evidence; modern scholarship.
Controls	Chronology; source criticism; historiographical questions; standards of evidence; acknowledgement of uncertainty.

IDEF0 element	A0 specification
Mechanisms	Historical expertise; libraries and archives; databases; translation; interdisciplinary comparison.
Outputs	A coherent, documented, qualified, and revisable historical interpretation.

Table 3. Decomposition of A0 into four analytical activities

Stage	Core activity	Principal output

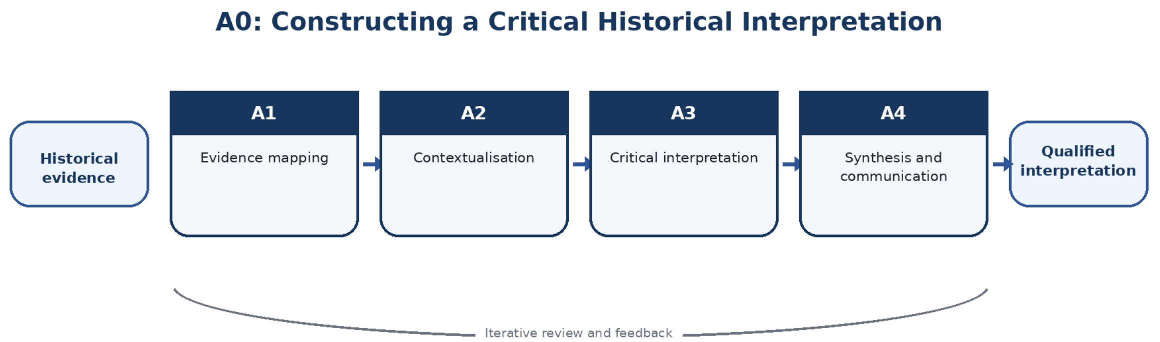

Figure 1. A0 sequence for converting historical evidence into a qualified interpretation.

4.3. Model B0: From historical interpretation to modern education

B0 begins with the qualified interpretation produced by A0. Its inputs include thematic summaries, primary source excerpts, timelines, images of instruments, controversy maps, and short historical cases. Its controls are learning outcomes, learner level, curriculum requirements, historical accuracy, accessibility, and ethical standards. Its mechanisms include teachers, curriculum designers, historians, museums, libraries, learning platforms, and digital media. Its outputs are educational modules and learning experiences that connect scientific content with historical reasoning.

B1, curriculum architecture, selects a manageable historical problem and aligns it with a scientific concept and an explicit learning objective. A lesson on Galileo, for example, should not merely celebrate the telescope; it might ask how instrument reliability, visual interpretation, and prior theory influence what counts as evidence. B2, interdisciplinary connection, links the case to mathematics, philosophy, literature, art, politics, economics, or religion where those connections illuminate the scientific issue.

B3, source-based inquiry, asks learners to compare evidence, identify assumptions, reconstruct disagreement, and justify an interpretation. Short, carefully framed excerpts are preferable to decontextualised quotations or overwhelming blocks of historical prose. B4, contemporary transfer, invites students to compare the historical case with a present problem such as climate modelling, biomedical evidence, algorithmic decision making, or public trust in expertise. The purpose is not to claim that past and present are identical, but to make the structure of evidence and authority available for reflection.

The educational literature suggests that historical narratives are most effective when they serve explicit conceptual and epistemic goals rather than functioning as entertaining additions (Clough, 2011; Matthews, 2014; Metz et al., 2007). B0 responds to that requirement by requiring every historical element to be linked to a learning outcome and every simplification to remain accountable to the A0 evidence base.

Table 4. Context definition for the B0 educational-design function

IDEF0 element	B0 specification
Function	Convert critical historical understanding into historically grounded education for modern audiences.
Inputs	Validated themes; source excerpts; timelines; instrument images; controversy maps; historical cases.
Controls	Learning outcomes; learner level; curriculum requirements; accuracy; accessibility; ethical standards.

IDEF0 element	B0 specification
Mechanisms	Teachers; curriculum designers; historians; museums; libraries; learning platforms; digital media.
Outputs	Modules and learning experiences connecting scientific content with historical reasoning.

Table 5. Decomposition of B0 into four educational activities

Stage	Core activity	Principal output

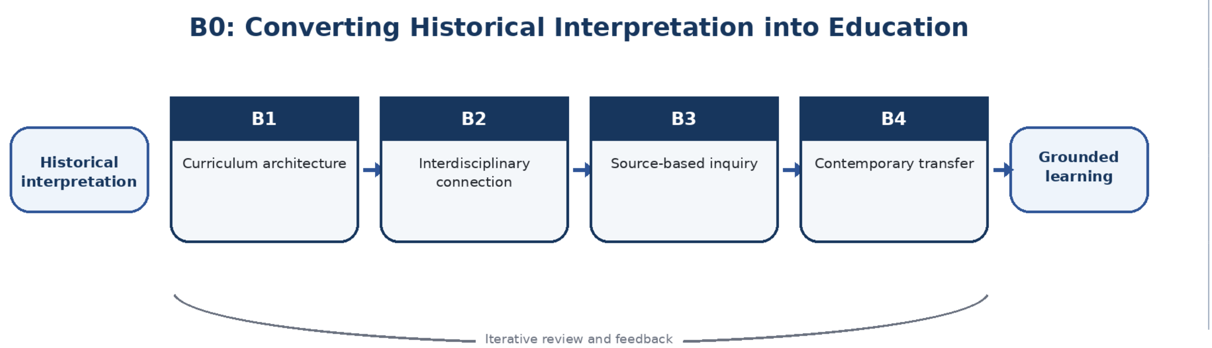

Figure 2. B0 sequence for converting historical interpretation into educational use.

4.4. The integrated A0-B0 framework

The combined result is a two-stage knowledge pathway. A0 transforms dispersed evidence into a structured historical interpretation. B0 transforms that interpretation into learning activities. The output of A0 is therefore the principal input of B0, while feedback from teaching can return to A0 when learners identify missing perspectives, confusing categories, or unsupported causal claims.

This integration prevents two common problems. The first is historical richness without educational usability: an account may be accurate but too expansive for a course or public audience. The second is educational simplicity without historical responsibility: a vivid story may teach a concept while misrepresenting the past. Linking the models makes adaptation visible and therefore open to review.

The framework also separates content from process. The historical content may change when new regions, actors, or sciences are added, but the functional questions remain useful: What enters the analysis? What controls it? Who or what performs it? What output is produced? The same questions can guide the later conversion of scholarship into curriculum, museum interpretation, or digital public history.

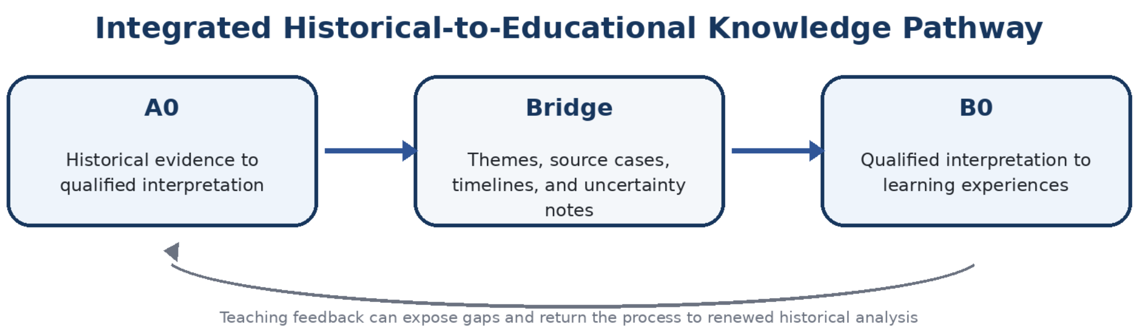

Figure 3. The integrated pathway linking historical analysis and educational design.

5. Discussion

The results support the central claim that the Scientific Revolution transformed a worldview by changing both explanations of nature and the conditions under which explanations became credible. The contribution of the article lies not in proposing a new date for the period or a newly discovered historical actor, but in joining a nuanced historical synthesis to an explicit model of knowledge processing and educational translation.

5.1. Reinterpreting the transformed worldview

The phrase "transforming the worldview" remains justified, provided that transformation is not confused with total replacement. The Earth's new status, the mathematical treatment of motion, the authority of instrumental observation, and the growing expectation of public testing altered how nature could be imagined. At the same time, older cosmologies, philosophical vocabularies, religious meanings, and practical traditions continued to shape inquiry. Change occurred through recombination as well as rejection.

This interpretation challenges a simple conflict model. Galileo's career demonstrates that intellectual arguments were also problems of patronage, rhetoric, institutional jurisdiction, and audience. Baconian method was simultaneously philosophical, political, and practical. Newtonian science combined mathematical power with theological and metaphysical commitments that do not fit a modern story of secularisation. The period is better understood as a redistribution of epistemic authority than as the disappearance of all non-scientific forms of thought (Biagioli, 1993; Harrison, 2015).

The global perspective introduces a second correction. European institutions were decisive sites of change, but the materials and information they processed travelled across wide networks. Navigation, medicine, natural history, and mapping relied on encounters that were often unequal and poorly credited. Including circulation does not reduce the significance of European developments; it explains more accurately the conditions under which they occurred (Cook, 2007; Raj, 2007).

5.2. What functional modelling contributes

Historical writing usually presents its final interpretation more clearly than the operations that produced it. A0 makes those operations visible. It distinguishes collecting material from contextualising it, contextualising from evaluating it, and evaluating from synthesising it. The distinction is analytically useful because weakness at one stage cannot be repaired merely by elegant writing at another.

B0 contributes a similar discipline to educational design. It requires the educator to explain why a historical episode has been selected, which learning objective it serves, what contextual information is necessary, and how learners will use evidence. The model therefore moves beyond the broad recommendation that history should be included in science teaching and specifies a route for doing so.

The novelty of the combined framework lies in three features. It connects historiographical judgement to pedagogical design; it preserves feedback between research and teaching; and it treats uncertainty as a control rather than a defect to be removed. These features distinguish the model from a static timeline or a list of famous discoveries.

Functional clarity must nevertheless be balanced with historical humility. IDEF0 boxes can create an impression of orderly progression even where research is recursive and interpretation remains contested. For that reason, the diagrams are accompanied by explicit feedback loops and by the rule that every output is revisable. The model organises scholarly labour; it does not reduce the past to a flowchart.

5.3. Educational and contemporary implications

The framework can support several forms of learning. In a secondary science class, a short case might help students distinguish observation from interpretation. In a university history course, the same case could be used to analyse patronage, authorship, and institutional power. In teacher education, it could become an exercise in designing questions that connect scientific content with the nature of evidence. Museums and digital platforms could use the model to reveal how a displayed instrument participates in a larger network of practice.

Historical cases also develop intellectual patience. Learners see that an unfamiliar claim may require new concepts, instruments, and standards before it can be fairly judged. They also see that novelty alone does not make a claim reliable. The balance between openness and disciplined criticism is central to scientific literacy and to public discussion of contested knowledge (McComas, 2008; Monk & Osborne, 1997).

Connections to present problems should be made carefully. Climate science, artificial intelligence, and biomedicine operate in institutions and technical environments very different from those of the seventeenth century. Historical analogy is useful when it clarifies questions about evidence, uncertainty, expertise, communication, or ethical responsibility. It becomes misleading when it treats every new technology as a second Copernican revolution or assumes that past controversy predicts present truth.

The educational value of the period ultimately lies in its combination of achievement and incompleteness. Learners encounter remarkable changes in explanation and method, but they also encounter error, exclusion, dependence, and unresolved debate. Science appears neither as infallible authority nor as mere opinion. It appears as a demanding collective practice whose reliability depends on methods, institutions, criticism, and responsible communication.

5.4. Limitations

Four limitations should qualify the findings. First, the chronological frame privileges developments between the sixteenth and early eighteenth centuries and cannot explain the full emergence of modern science. Medieval, ancient, Islamic, South Asian, East Asian, African, and Indigenous knowledge traditions require more sustained treatment than the present article provides.

Second, the source selection is purposive. It represents major interpretive themes but is not a comprehensive bibliometric or systematic review. Different selections could produce a different balance among astronomy, medicine, natural history, chemistry, technology, and social organisation.

Third, IDEF0 simplifies recursive intellectual work into named functions. The diagrams reduce complexity to make the process discussable; they should not be mistaken for a complete account of historical reasoning. Finally, the B0 model has not been tested empirically. Its educational value is supported conceptually by prior research, but effectiveness, accessibility, and learner response must be evaluated in actual settings (Höttecke & Silva, 2011; Matthews, 2014).

6. Conclusion

The Scientific Revolution changed the natural world that educated Europeans believed they inhabited and changed the practices through which claims about that world could become credible. Copernican astronomy, Keplerian mathematics, Galilean observation, Baconian programmes of organised experience, and Newtonian mechanics were central to that transformation. Their significance, however, becomes fully visible only when they are placed within networks of craft, instruments, print, patronage, religion, commerce, and collective judgement.

The historical analysis therefore replaces a single story of sudden rupture with a layered account of reorganisation. Mathematical description, instrumental observation, experimental intervention, and public scrutiny acquired greater authority, but they developed alongside older ideas and through institutions that both enabled and constrained inquiry. The resulting scientific culture was neither isolated from society nor produced by method alone.

The two functional models translate that interpretation into a usable framework. A0 identifies how evidence is mapped, contextualised, critically interpreted, and synthesised. B0 identifies how a qualified account is aligned with curriculum, connected across disciplines, explored through sources, and related cautiously to contemporary questions. Together, the models make visible the decisions that are often hidden between historical research and educational presentation.

6.1. Directions for future research

Future work should first expand the geographical and intellectual frame. Comparative studies could examine how knowledge moved among Europe, the Ottoman world, South Asia, East Asia, Africa, and the Americas, and how translation, empire, trade, and local expertise shaped what later entered European scientific archives. Such work would not merely add examples; it could alter the functional categories used in A0.

A second direction is digital application. The models could guide interactive archives in which users move from a claim to its sources, contexts, disputes, and later educational uses. Museum exhibits could make the mechanisms of knowledge production visible by connecting an instrument to makers, materials, observations, patrons, publications, and controversies.

The most important next step is empirical evaluation. Classroom studies should test whether B0-based modules improve conceptual understanding, historical reasoning, understanding of the nature of science, or calibration of trust in evidence. Research should compare learner levels, disciplines, and delivery modes and should document where the model creates excessive complexity or fails to represent diverse learners.

The enduring lesson of the Scientific Revolution is not that inherited knowledge should always be rejected. It is that reliable inquiry depends on the difficult work of questioning assumptions, creating better evidence, exposing reasoning to criticism, and revising explanations without erasing their history. A model that preserves those habits can help the period remain intellectually useful rather than merely commemorative.

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References

Bacon, F. (2000). *The New Organon* (L. Jardine & M. Silverthorne, Eds. & Trans.). Cambridge University Press. (Original work published 1620).

Biagioli, M. (1993). *Galileo, courtier: The practice of science in the culture of absolutism*. University of Chicago Press.

Clough, M. P. (2011). The story behind the science: Bringing science and scientists to life in post-secondary science education. *Science & Education, 20*, 701-717. https://doi.org/10.1007/s11191-010-9310-7

Cohen, H. F. (1994). *The Scientific Revolution: A historiographical inquiry*. University of Chicago Press.

Cook, H. J. (2007). *Matters of exchange: Commerce, medicine, and science in the Dutch Golden Age*. Yale University Press. https://doi.org/10.12987/yale/9780300117967.001.0001

Copernicus, N. (1978). *On the revolutions* (E. Rosen, Trans.). Johns Hopkins University Press. (Original work published 1543).

Daston, L., & Park, K. (1998). *Wonders and the order of nature, 1150-1750*. Zone Books.

Galilei, G. (1989). *Sidereus nuncius, or The sidereal messenger* (A. Van Helden, Trans.). University of Chicago Press. (Original work published 1610).

Gaukroger, S. (2006). *The emergence of a scientific culture: Science and the shaping of modernity, 1210-1685*. Clarendon Press. https://doi.org/10.1093/acprof:oso/9780199296446.001.0001

Gibbons, D. W., & Witherell, P. W. (2024). *A reference activity model for additive manufacturing: Powder bed fusion* (NIST AMS 100-60). National Institute of Standards and Technology. https://doi.org/10.6028/NIST.AMS.100-60

Harrison, P. (2015). *The territories of science and religion*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226184517.001.0001

Höttecke, D., & Silva, C. C. (2011). Why implementing history and philosophy in school science education is a challenge: An analysis of obstacles. *Science & Education, 20*, 293-316. https://doi.org/10.1007/s11191-010-9285-4

Kepler, J. (1992). *New astronomy* (W. H. Donahue, Trans.). Cambridge University Press. (Original work published 1609).

Koyré, A. (1957). *From the closed world to the infinite universe*. Johns Hopkins University Press.

Kuhn, T. S. (1957). *The Copernican Revolution: Planetary astronomy in the development of Western thought*. Harvard University Press.

Matthews, M. R. (2014). *Science teaching: The contribution of history and philosophy of science* (20th anniversary rev. and expanded ed.). Routledge. https://doi.org/10.4324/9780203123058

McComas, W. F. (2008). Seeking historical examples to illustrate key aspects of the nature of science. *Science & Education, 17*, 249-263. https://doi.org/10.1007/s11191-007-9081-y

Metz, D., Klassen, S., McMillan, B., Clough, M. P., & Olson, J. K. (2007). Building a foundation for the use of historical narratives. *Science & Education, 16*, 313-334. https://doi.org/10.1007/s11191-006-9024-z

Monk, M., & Osborne, J. (1997). Placing the history and philosophy of science on the curriculum: A model for the development of pedagogy. *Science Education, 81*(4), 405-424. https://doi.org/10.1002/(SICI)1098-237X(199707)81:4<405::AID-SCE3>3.0.CO;2-G

National Institute of Standards and Technology. (1993). *Integration definition for function modeling (IDEF0)* (FIPS PUB 183). U.S. Department of Commerce.

Newton, I. (1999). *The Principia: Mathematical principles of natural philosophy* (I. B. Cohen & A. Whitman, Trans.). University of California Press. (Original work published 1687).

Raj, K. (2007). *Relocating modern science: Circulation and the construction of knowledge in South Asia and Europe, 1650-1900*. Palgrave Macmillan. https://doi.org/10.1057/9780230625310

Smith, P. H. (2004). *The body of the artisan: Art and experience in the Scientific Revolution*. University of Chicago Press.

Westman, R. S. (2011). *The Copernican question: Prognostication, skepticism, and celestial order*. University of California Press. https://doi.org/10.1525/9780520948167