

Science and Technology

ENG 151

Lecture 1: Knowledge and evidence

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Our course

Two credits. Tuesday, 10:30–12:30. All classroom work takes place in this meeting.

Twelve lectures follow the history of science and technology and their effects on society.

The midterm week has no lecture. The final meeting is for recap, a guest, or another course activity.

Why study this history?

What did people know, and how did they know it?

What problems did they try to solve? Who could take part, and who benefited?

Past ideas help us understand present institutions, technical choices, and disagreements.

Knowledge in many places

Mesopotamia and Egypt, India and China, the Greek and Roman worlds, and later Islamic and European societies all enter our story.

Ideas travel with people, texts, instruments, and trade. Local needs shape what people do with them.



Egyptian pyramids

What is science?

Science develops explanations of the natural and social world through systematic inquiry.

Observations and evidence help us test explanations and revise them. Theories connect findings and support predictions.

Science is both a body of knowledge and an activity carried out by communities of researchers.

What is technology?

Technology includes tools, techniques, and organized systems that people use to accomplish practical purposes.

Scientific knowledge can support technology. Craft skill, experience, and repeated improvement also matter.

A stone tool and a computer network are both technologies, although their materials and organization differ greatly.

Science and technology interact

A scientific question asks how or why something happens. A design question asks how to achieve a purpose under constraints.

Better instruments make new observations possible. New explanations can suggest better instruments and processes.

Example: studying electricity and designing a dependable lighting system involve related, but different, questions.

Progress and new problems

A tool can remove one difficulty and create another.

Faster transport changes where people can work and live. It also raises questions about safety, energy, and the environment.

Technical capability alone does not decide how society should use it.



Technological ambition

Quality of life

Technology can improve housing, nutrition, education, and enjoyment.

Its value also depends on affordability, access, maintenance, and consequences for other people.

For an electric light, the lamp is only part of the story. A useful service also needs power and reliable distribution.



Thomas Edison with a lamp

Learning through practice

An apprentice learns by watching, trying, and receiving correction.

Some knowledge is difficult to express in words. A craftsperson learns to recognize the right sound, feel, or temperature.

Knowledge can disappear when nobody has the opportunity to learn the practice.



Apprenticeship

Writing and collective memory

Writing lets people preserve observations and instructions beyond one lifetime.

A record can travel to someone who did not witness the event. Other readers can compare it with later evidence.

The survival of a text does not guarantee that its claims are accurate.



Written signs

Printing and circulation

Producing many copies makes the same text available to more readers.

Shared texts make comparison and criticism easier, while errors and misleading claims can circulate too.

Access still depends on language, literacy, cost, and the institutions that distribute books.



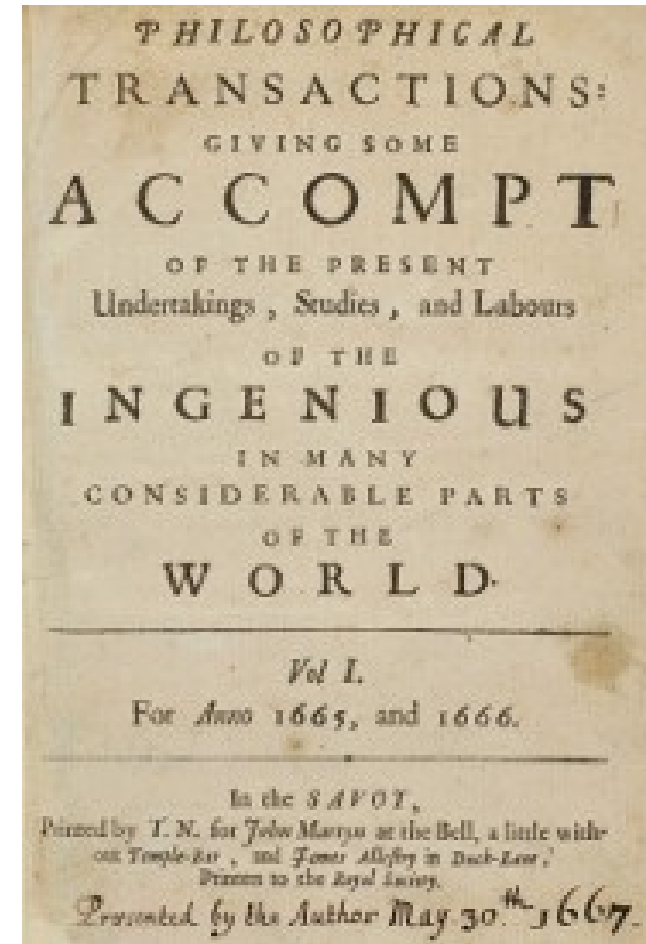
Printing workshop

A journal as a shared record

Philosophical Transactions began in 1665. It gave reports and observations a regular printed home.

Readers could build on reports, question them, and communicate further findings.

The journal's procedures changed over time. Publication in 1665 did not use today's peer-review system.



Philosophical Transactions title page

Reading an early report

This 1665 report describes a way of catching whales. Practical activities could become subjects of learned exchange.

What did the writer directly observe? What did someone else report?

A source lets us ask these questions. Its age or appearance alone cannot answer them.

it is by *Sennertus* out of *Crato*, for its goodness,

Of the New American Whale-fishing about the Bermudas.

Here follows a Relation, somewhat more divertising, than the precedent Accounts; which is about the new *Whale-fishing* in the *West-Indies* about the *Bermudas*, as it was delivered by an understanding and hardy Sea-man, who affirmed he had been at the killing work himself. His account, as far as remembered, was this; that though hitherto all Attempts of mastering the Whales of those Seas had been unsuccessful, by reason of the extraordinary fierceness and swiftness of these monstrous Animals; yet the enterprise being lately renewed, and such persons chosen and sent thither for the work, as were resolved not to be baffled by a Sea-monster, they did prosper so far in this undertaking, that, having been out at Sea, near the said Isle of *Bermudas*, seventeen times, and fastned their Weapons a dozen times, they killed in these expeditions 2 old Female-Whales, and 3 Cubs, whereof one of the old ones, from the head to the extremity of the Tayl, was 88. Foot in length, by measure; its Tayl being 23. Foot broad, the swimming Finn 26. Foot long, and the Gills three Foot long: having great bends underneath from the Nose to the Navil; upon her after-part, a Finn on the backs being within
B 2 paved

Philosophical Transactions, 1665. DOI: 10.1098/rstl.1665.0010

The Ottoman journal began publication in July 1862 through the Cemiyet-i İlmiye-i Osmaniye.

It introduced readers to scientific and cultural subjects, including physics, geology, history, and education.

Scientific communication also requires translation and a vocabulary that readers can use.

Why recording a claim matters

Writing forces us to specify what we mean. A clear claim states its scope, evidence, and remaining uncertainty.

Records make comparison possible. They help others distinguish what happened from what someone later remembers.

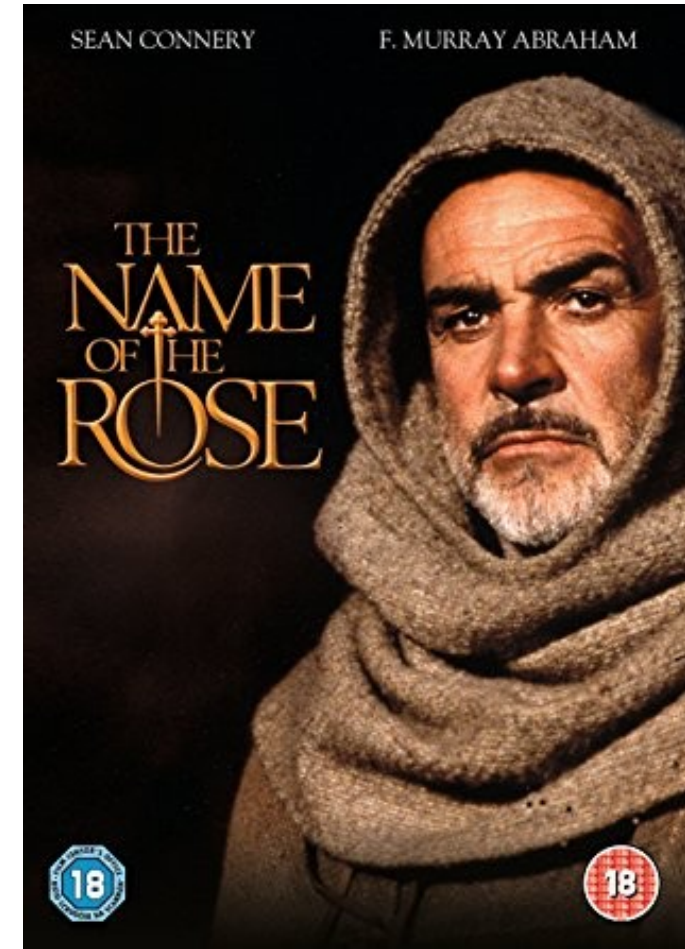
Written accounts and practical skill complement each other. Neither preserves every part of an experience.

Authority, reasoning, evidence

Authority can point us toward expertise. We still need to examine the reasons and evidence behind a claim.

Logical reasoning asks whether a conclusion follows from its premises. Observations help test those premises.

The Name of the Rose offers a fictional setting for discussing interpretation and competing explanations.



The Name of the Rose

A useful outline of inquiry

1. Notice a phenomenon and formulate a question.
2. Propose an explanation and derive a prediction.
3. Collect relevant evidence through observation or experiment.
4. Compare the evidence with the prediction, then revise or investigate further.

Explanation and prediction

Observation: a plant near a window appears to grow faster than a plant elsewhere.

Hypothesis: the difference in light affects growth.

Prediction: comparable plants receiving more light should grow differently when other important conditions stay similar.

A fair comparison

Use comparable plants and define how to measure growth before collecting results.

Keep water, soil, pot size, and other relevant conditions similar. Vary the light exposure deliberately.

Repeat the comparison. A single pair may differ for reasons unrelated to light.

Skepticism and alternatives

What other explanation could produce the same observation? Perhaps the plants differ in water or initial condition.

What evidence would count against the light explanation? A fair comparison may fail to show its predicted pattern.

An unexpected result calls for checking the method as well as the explanation.

Torricelli and the mercury tube

In 1644, Torricelli investigated a mercury-filled tube inverted into a dish of mercury.

He related the supported column to the pressure of the surrounding air.

An instrument made an apparently invisible property of air open to investigation.



Historical depiction

A prediction tested on a mountain

If air pressure supports the mercury column, the column should be lower where the pressure is lower.

In 1648, Florin Périer carried out the mountain experiment that Blaise Pascal proposed. The column fell at higher elevation.

The comparison connected an explanation with a testable consequence.



Pascal and Périer

Scientific knowledge can change

New evidence, instruments, and explanations can change what a community accepts.

A scientific revolution involves major changes in concepts and methods, although much everyday research is gradual.

Lecture 4 will examine the early-modern cases, including Copernicus, Galileo, and Newton, in their historical setting.

A study may combine both. The question determines what evidence is useful.



An everyday research question

Question: why do students choose one route to campus rather than another?

Travel-time records can reveal patterns. Interviews may reveal concerns about cost, safety, or convenience.

Together, these sources can explain more than either alone. A correlation still needs careful interpretation.

The limits of a four-step recipe

Research can begin with an observation, a practical problem, an existing theory, or a new instrument.

Researchers return to earlier questions, compare results, and respond to criticism.

The four-step outline helps us understand testing. Real inquiry often takes several routes and many attempts.

Who supports knowledge?

Research and technical work require time, resources, training, and places to work.

Rulers, religious institutions, armies, firms, and public bodies have supported different activities.

Support can enable inquiry while influencing which questions receive attention.



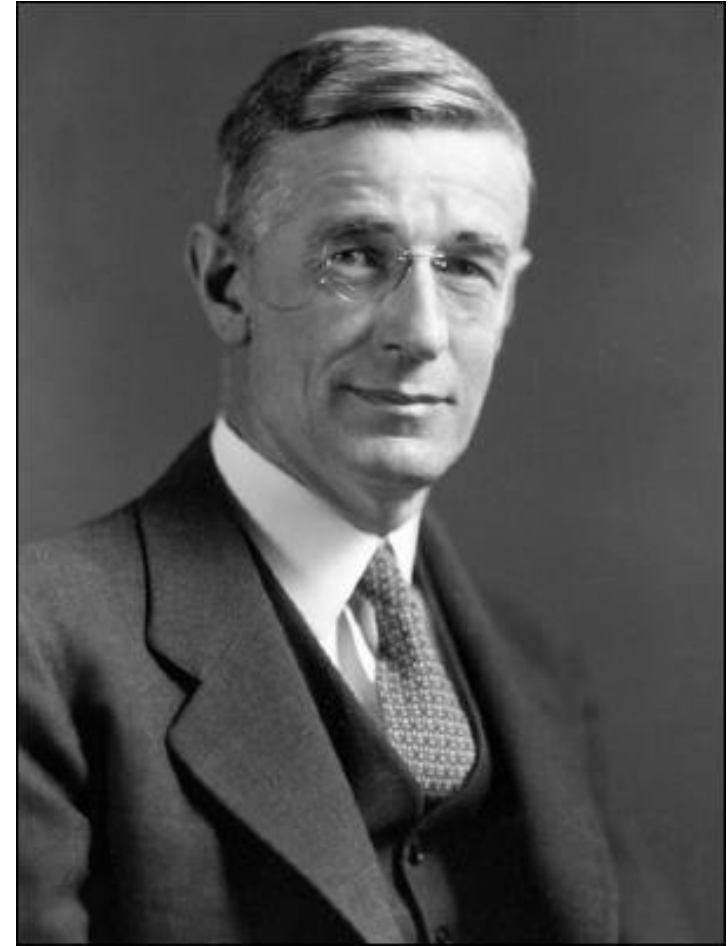
Sundial

Vannevar Bush and public research

In Science, the Endless Frontier (1945), Bush argued for sustained support of scientific research.

His argument connected scientific progress with public welfare and national needs.

Discussion: who should decide which research receives public support, especially when its practical value is uncertain?



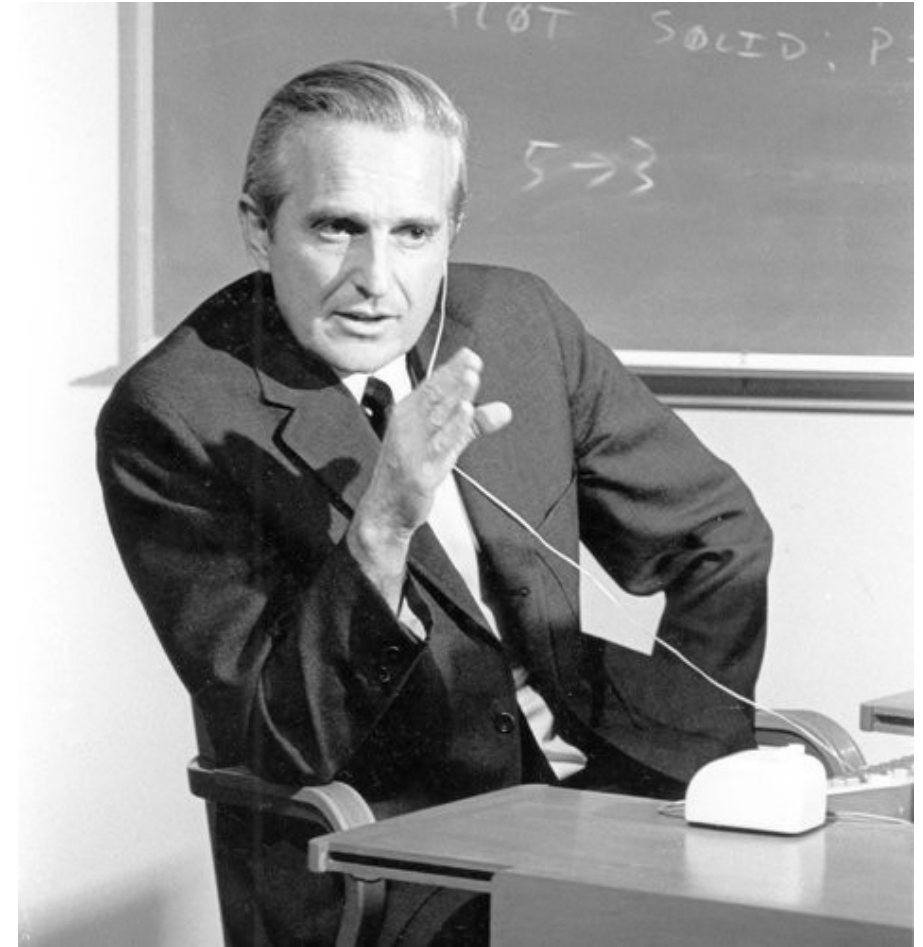
Vannevar Bush

Engelbart and collective knowledge

Douglas Engelbart emphasized how effectively people work together on difficult problems.

Shared records and communication tools can help a group remember, compare ideas, and coordinate work.

The benefit depends on how people use the tools and organize their cooperation.



Douglas Engelbart

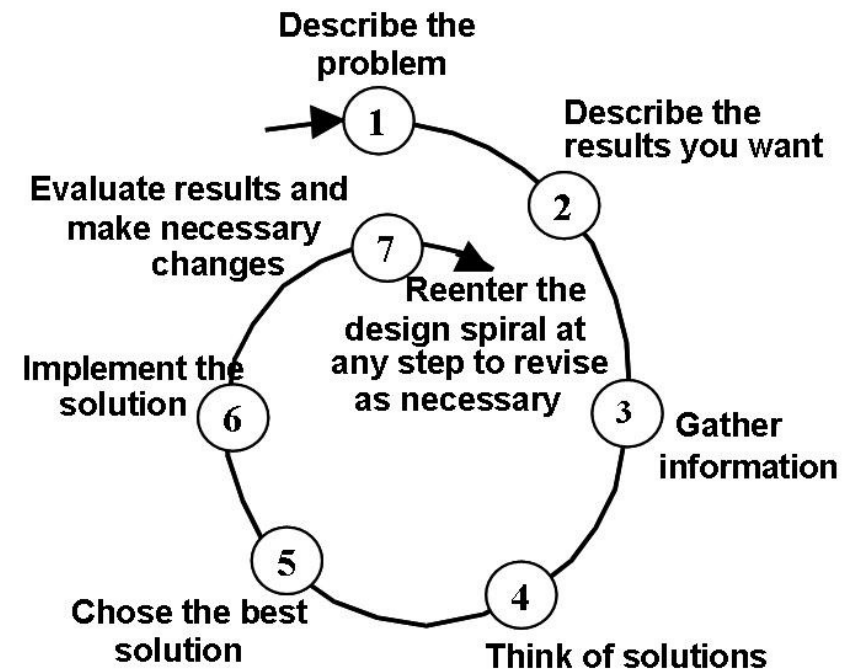
Technological problem solving

A design begins with a need and a description of the result we want.

Possible solutions must fit constraints such as cost, materials, safety, and time.

Testing the result can send us back to an earlier decision.

The Technological Method of Problem Solving



Problem-solving cycle

Design choices and tradeoffs

Example: a reading lamp should provide useful light at an affordable cost.

A brighter lamp may use more energy or create glare. A repairable design may need different materials or construction.

A good evaluation states whose needs matter and how success will be judged.

Leadership and national priorities

Turgut Özal's interest in science and computers illustrates the role of political leadership.

Decisions about research funding, education, and equipment can help science and technology prosper.

National ambitions need sustained institutional support and people who can carry the work forward.



Turgut Özal with early personal computers

What is a university for?

Universities help create knowledge and educate people who can question and extend it.

They also support personal development, professional preparation, and interaction with society.

Discussion: which of these purposes can we judge through an examination, and which require other evidence?



Education and student life

Finding scholarly work

Google Scholar searches across scholarly literature, including articles, books, theses, and other materials.

Useful starting details are the author, title, year, and publication. Follow references to earlier work.

A search result is a route to a source. Read the source before deciding what it establishes.

Google Scholar

☒ Articles ☐ Case law

Recommended articles

[The Role of Consumers' Perceived Security, Perceived Control, Interface Design Features, and Conscientiousness in Continuous Use of Mobile Payment Services](#)
J Zhang, Y Luximon, Y Song - Sustainability, 2019

[Identifying Physician Fraud in Healthcare with Open Data](#)
B Fan, X Zhang, W Fan - International Conference on Smart Health, 2019

[See all recommendations](#)

Stand on the shoulders of giants

[Go to Google Scholar](#)

Historical Google Scholar screenshot

Reading a source critically

What question does the author address? What evidence supports the answer?

Which assumptions and limitations affect the conclusion? Does the source distinguish observation from interpretation?

Can you locate the original study or document behind a repeated claim? Record enough detail for another reader to find it.

A claim to discuss

“More technology always improves quality of life.”

Choose one technology. Identify a benefit, a possible cost, and the people affected.

What evidence would help us judge the claim? Consider access and consequences over time.

One possible line of reasoning

Electric lighting can extend the hours available for reading and work.

Its benefit depends on access, price, reliability, and how people use the additional hours. Energy production also has consequences.

The word “always” makes the original claim too broad. A better judgment specifies the technology, users, conditions, and outcome.

The main connections

Evidence connects a claim with observations that other people can examine.

Records and institutions help knowledge survive, circulate, and receive criticism.

Technology changes what people can do. Social choices influence the purposes it serves and the effects it has.

Questions for review

1. How does a scientific question differ from a design question?
2. Why does a plausible explanation still need testing?
3. How do writing and publication change the use of knowledge?
4. Why can a useful technology create new problems?

Review: model answers

1. Science seeks explanations. Design seeks a workable result under stated constraints.
2. Several explanations may fit an observation. Tests help distinguish them.
3. Records preserve claims and let other people compare and challenge them.
4. New capabilities change behavior, resource use, and relationships. Benefits and costs may fall on different people.

The historical route ahead

Lectures 2–5 examine ancient knowledge, medieval exchange, early-modern science, and Ottoman institutions.

Lectures 6–8 examine steam and factories, electricity and chemistry, mass production, and organized science.

Lectures 9–12 examine computers, networks, Industry 4.0 and AI, then science and society.

Next: ancient knowledge

How did people measure land, record transactions, and make calendars?

How did practical needs interact with mathematical reasoning and explanations of nature?

We will follow selected objects and problems across early societies.

Reference: kinds of knowledge

Aristotle distinguished theoretical inquiry, practical reasoning, and productive activity.

Theoretical inquiry seeks understanding. Practical reasoning concerns action. Productive activity concerns making something.

These historical categories help frame a discussion. Their meanings do not exactly match modern university disciplines.

Reference: software and evidence

A claim that a software-development method improves quality needs evidence about actual work.

Results may depend on the team, task, comparison method, and definition of quality. Personal experience can suggest a question but cannot establish a universal result.

The same reasoning applies when judging claims about teaching methods or organizational change.

Reference: research perspectives

Positivist approaches emphasize systematic observation and explanation of patterns.

Interpretive approaches examine how people understand their experiences and social setting.

Critical approaches examine power and question conditions that shape social life.

These perspectives influence a study's questions and interpretation. They do not determine one fixed data-collection technique.

Reference: specialist literature

ACM and IEEE provide important routes to computing and engineering literature.

Check the publication and the article itself, including its date, methods, references, and limitations.

The images are historical. The document count shown in the IEEE banner is not a current total.



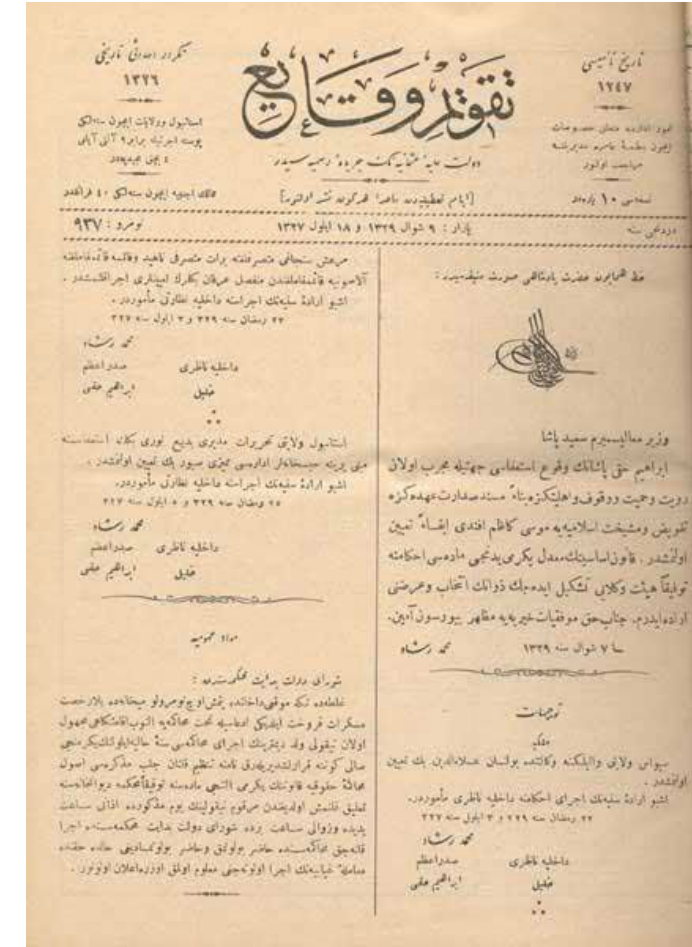
ACM and IEEE Xplore images

Reference: Mecmûa-i Fünûn

Mecmûa-i Fünûn brought scientific and cultural subjects to Ottoman readers.

This page illustrates the role of journals in sharing ideas and developing a scientific vocabulary.

A complete citation also records the issue, date, and page number when available.



Mecmûa-i Fünûn; exact issue and date not specified

Selected sources

Royal Society: history of Philosophical Transactions. Abdullah Uçman: “Mecmûa-i Fünûn,” TDV İslâm Ansiklopedisi.

Museo Galileo: Torricelli’s and Pascal’s barometric experiments. NSF: Science, the Endless Frontier.

UC Berkeley: Understanding Science. Doug Engelbart Institute: Collective IQ. Google Scholar: About Google Scholar.