From Khayyām's Calendar to the Chartaqi: Bringing Persian Heritage into Astronomy Classrooms in Iran

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Abstract

Iranian astronomy education often presents celestial concepts apart from the cultural materials through which communities have long interpreted the sky. This article examines how Mehr Observatory in Bushehr organised a programme around four resources, the Jalali calendar and seasonal festivals, Canopus as observed from southern Iran, astronomical imagery in Persian poetry and the Jereh Chartaqi. Between 2022 and 2025, 30,000 secondary-school students joined in observations, model building, literary interpretation, international exchange, and field-based inquiry. Evidence comes from activity records, student work, observation notes, and reflective discussions produced during implementation. The article asks how familiar heritage can become a disciplined route into astronomical reasoning and what organisational conditions make that work credible. The activities linked equinoxes, latitude, stellar motion, and solar orientation with regional practices; yet they also exposed gaps in teacher preparation, documentation, and tested learning resources. The programme indicates that heritage gains educational value when learners examine claims, construct representations, and connect local knowledge with astronomical evidence in class.

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1. Heritage at the Edge of the Astronomy Classroom

Iran's astronomical heritage remains highly visible in public culture, yet its place in school astronomy is uneven. The Solar Hijri calendar begins at the vernal equinox, seasonal festivals organise civic life, and celestial imagery remains familiar through poetry, although classroom instruction often reduces the subject to definitions and diagrams detached from those settings. Jafari identified more than 200 local astronomy societies and centres, with amateur networks carrying a substantial share of public education after 2000 (Jafari, 2020). This separation produces the article's central question. How can Iranian heritage enter astronomy lessons as evidence-bearing material instead of mere decoration? Heritage scholarship recognises monuments, landscapes, practices and records as astronomical resources, but classroom use requires tasks that learners can observe, model and discuss critically (Belmonte & González-García, 2016, Ruggles, 2019).

Mehr Observatory in Bushehr developed the programme with student research centres, schools, and educational institutions, and the local setting shaped both content and organisation. Bushehr's southern horizon made Canopus observable, regional poetry gave Suhail a recognisable cultural voice, and nearby Fars supplied architectural remains for field inquiry. Coordination therefore involved suitable dates, access to locations, communication with teachers, and a sequence through which classroom interpretation could lead into observation or modeling.

The four strands addressed one educational problem through different astronomical questions. Calendar activities examined the solar year; Suhail turned latitude into a local constraint on visibility, and poetry required students to translate figurative descriptions into claims about motion or classification. The Jereh Chartaqi introduced orientation, modeling, and the limits of architectural interpretation. Astronomy Day

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in Schools and teacher preparation supported by the IAU Office of Astronomy for Education extended this work beyond one classroom (Pompea & Russo, 2020).

The evidence places clear limits on the conclusions. Activity records document implementation, participant reasoning, and questions generated during the work, but provide neither a controlled comparison nor a standardised learning test. The article therefore examines pedagogical design and changes in explanation, treating the records as evidence of process instead of proof of effectiveness. Such restraint matters in archaeoastronomy, where an attractive alignment may gain authority more quickly than archaeological evidence permits (Ruggles, 2015).

2. Setting, Records and Limits

Secondary-school students participated through Mehr Observatory and partner institutions in classrooms, at observation sites, and during heritage visits. The documentary base included observation notes, student models, presentations, photographs, field records, reports, and reflective discussions produced during teaching. Reviewing these materials together made it possible to reconstruct implementation and compare explanations offered at different stages without treating the records as a formal experimental dataset.

Across the different strands, the activity sequence retained a common structure: a familiar practice or artefact introduced the problem, students identified an astronomical claim, produced an observation or representation, and compared their interpretation with the available evidence. The closing discussion returned to the heritage source and distinguished supported relations, symbolic meanings, and questions requiring further research. The organisation nevertheless changed with the demands of the task. Calendar sessions used solar diagrams and date records; Canopus required suitable dates, a clear southern horizon, and attention to weather, whereas poetry relied on close reading and physical models, and the Chartaqi project required maps, craft materials, and a field visit.

The programme combined contextual, observational, inquiry, and experiential approaches, with each label describing the work students performed. Learners first encountered a problem in a recognisable setting and then used astronomy to examine it. This choice fits cultural approaches to scientific representation (Salimpour & Fitzgerald, 2024) and the astroEDU model, which expects learning goals, materials, and evidence to accompany an activity (Russo et al., 2015). Logistics consequently formed part of pedagogy, as an obstructed horizon, uncertain orientation, or undocumented source could weaken the investigation.

Using one instrument across all activities would have concealed differences among their outcomes and the forms of reasoning they elicited. Explanatory talk before and after observation was most informative for Canopus, whereas models and translations from metaphor to motion mattered more in the poetry work. In the Chartaqi investigation, measurements and competing interpretations carried greater value than a final answer. This mixed record supports an account of practice, but it also exposes missing rubrics, common prompts, and a central archive; future comparison will require shared timing and comparable forms of student response.

3. Khayyām's Calendar and Seasonal Practice

The calendar strand began with an object that students use daily but seldom examine astronomically. The Iranian calendar starts at the vernal equinox and follows the vernal-equinox year, whose present mean length is about 365.2424 solar days (Heydari-Malayeri, 2004). Nowruz linked the year's opening to the March equinox and Yalda directed attention to the winter solstice and changing daylight, with Tirgan and Mehregan extending the discussion toward seasonal memory and agriculture. Khayyām entered through the Jalali reform and the cultural record of the Nowruznameh, allowing calculation, history, and living practice to meet without becoming equivalent (Kennedy, 1963, Khayyam, 2012).

Students examined shadow length, sunrise direction, Earth-Sun models, and calendar comparisons so that broad praise of "ancient accuracy" could be replaced by testable relations. Which event begins the year? Discussion then moved to daylight extremes at the solstices, the effect of latitude on the Sun's apparent path, and the expectation of exactly twelve hours of day and night at the equinox. That expectation opened discussion of refraction and the apparent solar disk, and students considered how calendar maintenance depends on observation, calculation, and intercalation.

Participation in Astronomy Day in Schools gave several calendar sessions an international setting in which Iranian students presented Nowruz and Yalda, shared photographs of Haft-Sin and family gatherings,

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and compared latitude measurements with groups elsewhere. Explaining a local practice to peers who knew the same equinox through another season, calendar, or festival required students to make the astronomical relation explicit. Astronomy supplied a common reference for the exchange, although cultural responses to that reference remained distinct.

This strand clarified one condition under which a festival becomes educationally productive. The lesson first identified a measurable celestial relation and then returned to the cultural practice with greater precision, and international collaboration required students to present their own calendar, terms, and images instead of a generic cultural package. This emphasis on local authorship is consistent with participatory approaches promoted in international astronomy education (Russo & Gomez, 2015).

4. Suhail on the Bushehr Horizon

Canopus, known regionally as Suhail, gave the programme its most place-specific observation. With a declination near minus 53 degrees, the star culminates only about eight degrees above Bushehr's southern horizon, where haze, buildings and site choice can determine whether it is seen at all. Participants compared Bushehr with northern Iranian cities, predicted where Suhail would rise and how high it might appear, then used a celestial globe and horizon sketches to relate those predictions to latitude and declination. When the star appeared low in the south, the coordinate system acquired an immediate observational purpose.

Regional accounts associate Suhail's seasonal appearance with moderating summer heat, and facilitators used that association to separate stellar visibility, seasonal timing and the physical causes of temperature change. The discussion preserved the saying as evidence of sustained local attention to the sky, without converting it into a direct causal model. A verse by Fayez Dashti then gave the observation a literary and geographical frame.

> Suhail andar Yemen Bolghar suzad,
> Del-e ashegh ze hejr-e yar suzad...

The reference to Yemen led students back to the sky map, where they examined the star's southern association and its symbolic force in Bushehr. Recorded discussion after the observation contained a more differentiated vocabulary, with participants referring to latitude, declination, horizon altitude and season instead of treating "clear weather" as a complete explanation. The evidence remains qualitative, yet it identifies a plausible learning process in which local knowledge directed attention toward Suhail and direct observation required a coordinate-based account of its visibility.

5. Persian Poetry as Astronomical Evidence and Metaphor

Persian poetry offered a large archive, so selection required an explicit relationship between each verse and an astronomical task. Students first classified examples as observational reference, seasonal or cosmological interpretation, and symbolic use, which helped them identify the kind of claim being made before translating it into contemporary terms. Manuchehri Damghani's account of Banat al-Naśh and Polaris provided the clearest case for examining apparent motion.

> Hami bargasht gard-e Qotb-e Jaddi,
> Cho gard-e babzan morgh-e mosamman;
> Banat al-Naśh gard-e u hami gasht,
> Cho andar dast-e mard-e chap falakhan.

A ball attached to a string reproduced the sling image and supported the discussion of counterclockwise motion around the celestial pole. Khayyām's verse then shifted attention from direction to classification.

> Gāvi ast dar āsemān o nāmesh Parvin,
> Yek gāv-e degar nehofte dar zir-e zamin,

Students identified Pleiades and Taurus, then distinguished a physical star cluster from a conventional constellation figure. The verse showed the organising role of cultural naming in the night sky and the shift in classification when imagery was compared with observation. References to sa'd and nahs encounters introduced readings of planetary conjunctions, which students set beside the definition of an apparent close approach. Hafez's verse brought Venus into the interpretive exercise.

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Dar āsemān na 'ajab gar be gofte-ye Hafez,
Sorud-e Zohreh be raqs āvarad Masihā rā.

Students examined the planet's brightness and visibility alongside its association with music and beauty. Literary interpretation opened the problem, after which observation records and planetarium views tested claims about position and appearance. Poetry, therefore, worked as a language for setting astronomical questions, condensing direction, comparison, and memory into lines that could be unpacked through models and observation. Moving between these semiotic systems is central to astronomy learning (Salimpour & Fitzgerald, 2024).

6. Investigating the Jereh Chartaqi

The architectural strand centred on the Jereh Chartaqi in Fars, using the transcription adopted in Assasi's archaeoastronomical study for a square domed unit opened by four arches. Prominent in Iranian architecture from late antiquity, the form later appeared in religious and secular settings, with monumental early Sasanian examples at Firuzabad associated with Ardashir I. Mehr Observatory students selected Jereh through the National Student Scientific Research Competitions and gathered photographs, plans, and earlier interpretations before visiting, so fieldwork began from competing expectations about solar orientation.

Assasi's inventory includes 25 Iranian chartaqi and records incomplete archaeological documentation for several examples (Assasi, 2014). Students, therefore, separated observed orientation from calendrical function and distinguished a possible solar relation from evidence concerning builders or users, following Ruggles's warning that alignment alone carries limited explanatory weight (Ruggles, 2015). At the site, they recorded openings, orientation, and surviving fabric.

In class, cardboard scale models and phone flashlights approximated sunrise and sunset directions at equinoxes and solstices. Students marked illuminated surfaces and shadow boundaries, then identified measurements that required improvement. Would horizon altitude alter solar direction? The question also focused attention on model dimensions, the original form of the openings, and possible reconstruction, showing how a model can expose uncertainty as effectively as it illustrates a proposed alignment.

Preservation concerns emerged from the same inquiry, as damaged fabric and missing context reduce historical knowledge and later educational use. The Heritage of the Sky project had already received more than 200 photographs and gathered 250 people at its award event (Jafari et al., 2020); the Jereh work translated that public interest into a smaller exercise in documentation and interpretation.

7. Lessons from Implementation and Teacher Preparation

Coherence depended on a shared set of decisions concerning the heritage source, the astronomical relation open to examination and the limits of evidence. What evidence is available, and what remains interpretive? Requiring every connection to produce an observation, representation, or research question linked the calendar, stars, poems and monuments without forcing them into one method. Mehr Observatory organised observing conditions, communication with research centres and continuity between sessions; teachers contributed knowledge of students and schedules, and international partners supported ADiS comparisons. Iran's astronomy network offers considerable capacity, although resources and institutional support remain uneven (Jafari, 2020).

Teacher preparation presented the immediate constraint. A two-day Teacher Training Programme supported by the IAU Office of Astronomy for Education involved 20 primary teachers from Fars Province and Pasargadae, combining astronomy education and archaeoastronomy with a visit to Persepolis. Participants framed possible astronomical features as research questions, and their feedback indicated that literature and architecture had rarely entered earlier teaching.

Resource design raised a related issue. A heritage lesson requires verified sources, an age-appropriate task, local language, practical instructions, and a clear distinction between observation and interpretation. The Heritage of the Sky project showed the reach of storytelling and visual media through a national initiative organised by 20 communicators and outreach professionals (Jafari et al., 2020), but classroom use requires documented and reproducible goals.

Future work should prioritise a shared archive, common observation prompts, and modest evaluation tools. Brief explanation tasks before and after an activity could record conceptual change without converting

each session into an experiment, and schools need procedures for field safety, site permission, and image records. Organisational memory must accompany cultural memory.

8. Conclusion

Taken together, the activities respond to a persistent separation in Iranian astronomy education, where abundant cultural materials rarely enter classroom accounts of the sky. Mehr Observatory organised four routes through the calendar: Canopus, poetry, and the Jereh Chartaqi; each began from a local or national reference and required observation, modeling, or critical comparison.

The strongest work used place and practice precisely. Bushehr's latitude made Suhail a low southern star; Persian verse supplied language for motion and grouping, the Chartaqi model brought uncertainty into architectural inquiry, and ADiS placed Nowruz and Yalda within international comparison. Different tasks, therefore, shared one evidential structure.

The records support a limited conclusion about pedagogical design, not a measured claim of effectiveness. More differentiated explanations appeared when familiar heritage led students toward an inspectable problem, and teachers required source criticism, activity design, and organisational support. Without those elements, heritage risks becoming decoration or unsupported history.

The next stage should preserve local character and strengthen documentation across partners through common prompts, samples of student work, and clearer criteria for interpretation. Persian heritage can enter astronomy classrooms as disciplined inquiry when evidence, context, and responsibility remain connected.

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