Journal of Scientific & Industrial Research
Vol. 84, January 2025, pp. 72-81
DOI: 10.56042/jsir.v84i1.11717

Cinematic Technology Augmenting Narrative Pace and Progress: The Role of Audiovisual Breathers in Communicating Scientific Concepts

Matiur Rahman[1,2]* & N K Prasanna[1,2]

[1]CSIR-National Institute of Science Communication and Policy Research (NIScPR), New Delhi 110 012, India

[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201 002, India

Received 10 June 2024; revised 20 August 2024; accepted 20 September 2024

In this research paper a framework for analysis of narrative progress in the popular Indian science television serial titled *Bharat Ki Chhāp* (The Identity of India) was attempted on the basis of 643 minutes (10.717 hours) of film data by locating Audiovisual (AV) 'spaces' that did not have dialogues, voice-over or a narrative spoken by an offscreen commentator and instead relied either on music and ambient sound or a blend of both. These spaces which we would prefer calling Audiovisual Breathers, show the visuals of the preceding story sequence with visuals of the sequence to follow. This technique of editing such shots together create a transition and link the narrative of the next story. These Audiovisual Breathers were analysed for their role in driving the narrative progress by looking at their total count, temporal occurrence, as well as the percentage and screen-time share in the total duration of each episode of the TV serial *Bharat Ki Chhāp*. The cumulative duration and cumulative percentage of AV Breathers were also analysed to show how they maintained the flow of the various stories in each episode to sustain audiences' interest. Having classified the AV Breathers on the basis of their duration and terming them as Short AV Breathers (SABs), Long AV Breathers (LABs) and Song Interludes (SIs), our study revealed that a combination of all the three categories of breathers occupied a screen-time of 73 minutes (1:33) in a 643 minutes(10.717) long television serial, with the SIs taking the largest share of 45 minutes and 12 seconds, followed by LABs (25' 24") and SABs (2' 20") providing a clear pointer of what constitutes the communication of core scientific concepts in the popular Indian science TV serial *Bharat Ki Chhāp*, in terms of a single metric of AV Breathers.

Keywords: Film Transition, Science film, Song interludes, TV serial, Visual breathers

Introduction

Telecast nationwide in 1989, the 13-part Indian science TV serial titled *Bharat Ki Chhāp* (The Identity of India) originally produced on celluloid and themed on the history of science, technology, engineering, architecture and mathematics in South Asia was directed by Chandita Mukherjee and produced by the National Council for Science and Technology Communication (NCSTC), Department of Science and Technology, Government of India.[1] Produced in Hindi language along with an English subtitled version, the serial *Bharat Ki Chhāp* (BKC) was subsequently dubbed into Tamil, Malyalam, Telugu, Gujarati, Marathi, Bengali and Kannada for reaching out to Indian states of Tamil Nadu, Kerala, Andhra Pradesh, Gujarat, Maharashtra, West Bengal and Karnataka respectively.[2] The central themes around which this popular science TV serial wove its various stories, after setting the stage for the entire serial through its opening episode of Introduction, progressed through the Stone Age till 3500 B.C., the Harappan Civilisation - 3500 B.C. to 2000 B.C., the Iron Age - 2000 B.C. to 500 B.C., the Age of Codification, Ayurveda and Astronomy, Mathematics and Temple Architecture, Stagnation and a Changing World, Colonialism and the Industrial Revolution 1800 to 1900, the Freedom Struggle and the Scientific Community 1900 to 1947, Independent India 1947 to the Present, concluding with an examination of the Retrospect and Prospect in the last (13th) episode. This science television serial was received well by the audience across the country and earned for the producer, NCSTC an appreciable revenue through sponsorship by an Indian private sector manufacturer of TV sets.[3]

A characteristic feature of popular-cultural forms, including films and television programmes is the balance they are able to strike between the content and its on-screen presentation leveraging various cinematic tools which aid the continued engagement of the audience from the time the first visuals and audio tracks are experienced by the viewer till the time the end credits roll. This is where the 'pacing' becomes a

*Author for Correspondence
E-mail: matiurrahman@gmail.com

crucial component of producing a TV programme. The amount of information delivered per unit of time is normally referred to as programme pace. The pace and visual effects of television programmes stimulate the viewer's cerebral interest by facilitating comprehension of information presented as the essential content of the programme. Designers of television programmes tend to select a pace or speed that aid better reception of programme content by the watching audience. Integrating simpler and less content-heavy visual sequences after a content or concept-rich sequence is a technique employed by producers of television programmes to make the programme appeal to a larger and more diverse set of audiences. Music and examples drawn from real-life aimed at co-relating the central concepts in the programmes also offer viewers time to make inferences and enrich the information being delivered.[4]

This study, therefore, focused on one such cinematic tool - the audiovisual breathers which are audio-video segments that do not have narrative spoken by an off-screen commentator, dialogues, or voice-overs and which instead relied mostly on either music or ambient sound of the location or a mix of both. These audiovisual breathers supported, propelled, enriched and augmented the progress of narrative and served mostly as transitions to link various stories and ideas together, especially in long duration non-fiction television episodes. These audiovisual breathers helped keep the interest of the viewers sustained through the film, especially in content-heavy sequences of an episode. Since the episodes of BKC were of a rather long duration, with an average duration of over fifty minutes each, the importance of visual breathers assumed added importance. The rationale of the present study, therefore, was to focus on the types, duration and the pattern of their appearance and the role they played to help augment the watchability of the BKC episodes. The role the narratives play has attracted the attention of scholars in the past. Gellereau[5] has viewed narratives "not simply as a way of translating scientific discourse, but as a mediation" that involved both the producers and the recipients of the narration. In other scholars' works, narratives take centrestage when exploring ways of perceiving the world, constructing knowledge, and the social representation of science.[6]

In the usual run of treatment of science television programmes produced generally for Indian audiences, the linearity of exactly matching the most relevant visuals as expected by the audience with exactly the same suggestion on soundtrack often made the narrative progress in an undesirable and highly predictable manner. This approach of production of programmes often mars the impact a TV programme. An audience being able to predict the visuals before the director actually brought them up on screen, is an almost sure guarantee of the lost ground that the filmmaker wished to win with the watching audience. It is precisely here that metaphors and analogies are used as universal tools for explanation of scientific subjects.[7] Additionally the use of music, humour, and drama in documentaries is something that most traditional academics are not used to seeing in research.[8] As far as the construction of science on television is concerned, for most of the general population 'science' is constructed through TV science programmes, both 'serious' and fictional.[9] Such a ‘construction’, therefore, is not just limited to communicating a scientific achievement alone, it becomes a bearer of the social meanings of ‘science’, argue the authors. A particularly good example of marrying a highly abstract and hypothetical subject from the field of theoretical physics and to make it imaginable to lay persons is a science programme titled *The Elegant Universe* (2003)[10] which successfully attempted a blend of truths of science and demands of aesthetics, a judicious combination of which appealed to even an initially non-interested audience. Historians of science have often turned to films for its ability to provide connections between scientific knowledge and popular culture[11] which has a profound impact on the critical understanding of a civilization. This is amply evidenced in the stories of mathematics and temple architecture dealt with in the episode 7 of *Bharat Ki Chhāp* when it asked how did science grow, how did we absorb the new techniques it brought in its wake and why a civilization that once led, fell back while others forged ahead. These were some of the contexts, amongst others, against which a measurable metric of audiovisual breathers in the popular Indian science TV serial titled *Bharat Ki Chhāp* have been examined.

The science TV serial *Bharat Ki Chhap* was a good pointer and a template worth emulating to handle the pre-production, production and post-production of science programmes that are produced today, especially when the science serial is the only one to look up to even after thirty three years of its nationwide telecast.

The present study, therefore, attempted at making a critical enquiry into the themes around which the breathers have been created, their pattern of appearance, the prompts that led to their placement at a particular point on the timeline of the episodes, the co-relation the numbers of breathers had with the subtitle under which the subject of various stories were presented in the thirteen episodes of BKC.

Key Scientific Concepts in the Indian Science TV Serial Titled *Bharat Ki Chhāp*

Whether it was the various SIs, SABs and LABs, all the thirteen episodes of the science TV serial spun their stories around scientific concepts that not only drove the progress of the narrative in all the episodes but also impacted its pace. The key broad scientific concepts dealt with in various episodes went as follows:

Though episode 1 (Introduction) raised a curtain over the entire science TV serial, the key scientific concept established in the opening episode was the technique of radiocarbon dating. While episode 2 (The Stone Age till 3500 BC) dealt with primitive tools, cave paintings, food storage and agricultural transition, the key scientific concepts included Ethnoarchaeology (megaliths), replication of seeds, and early representation of symbols. The episode 3 (The Harappan Civilization 3500 B.C. to 2000 B.C.) dwelt on the concept of city planning, drainage systems and standardized weights and measures. Besides manual foraging of iron tools, precise construction of fire altars in various shapes using standardized bricks were the scientific concepts dealt in episode 4 (The Iron Age 2000 B.C. to 500 B.C.) The episode 5 (The Age of Codification) dealt with Panini- the grammarian and his Shivasutra formula while the ancient Brahmi and Tamizhi scripts were discussed as the first scripts to be deciphered unlike the Harappan script. The concept of a simple lever device to lift water also formed a part of the episode 5. Approximation of Pi as 3.1416, Brahmagupta's geometrical formula for the area of a cyclic quadrilateral, expressed in terms of its sides, smelting iron alloys for specialized purposes (The Iron Pillar in Delhi) were the concepts audiovisually established in episode 6 (Ayurveda and Astronomy). The technique of trabeate construction and the concept of Abacus and zero formed the scientific content of episode 7 (Mathematics and Temple Architecture). Mechanical principles like parallel worm gearing as in the cotton gin and sugarcane presses were the scientific concepts dealt in episode 8 (Synthesis and Growth) besides the horizontal motion of animals or men converted into water wheel's vertical motion apart from the concept of right angled gearing. While episode 9 (Stagnation and a Changing World) focused on accurate observations for sea voyages, astronomy, and ship building, the scientific concept dealt in episode 10 (Colonialism and the Industrial Revolution1800 to 1900) were about iron extraction. Wireless communication and light scattering in liquids formed the basis of scientific content in episode 11 (The Freedom Struggle and the Scientific Community-1900 to 1947). While the concepts themed on scientific planning, scientific policy resolution, and green revolution were the subjects dealt in episode 12 (Independent India -1947 to the Present), the concluding episode 13 (Retrospect and Prospect) had remote sensing, satellite images, and ethnobotany as central scientific concepts.

Materials and Methods

For the purposes of study, all the thirteen episodes were watched for recording the Time Codes (TC) of the entire video and sound track while also writing down the English subtitles text supered on frame bottom of each episode. The Hindi spoken part of each script was also transcribed separately with time codes, following which the audiovisual breathers were marked separately for each episode. All the audiovisual breathers were then divided into three categories as SI, SAB and LAB. The method followed in manual acquisition of data of the science TV serial *Bharat Ki Chhāp* is outlined in Fig. 1. Any visual breather that was less than 15 seconds were classed as Short Visual Breather while the ones exceeding fifteen seconds were

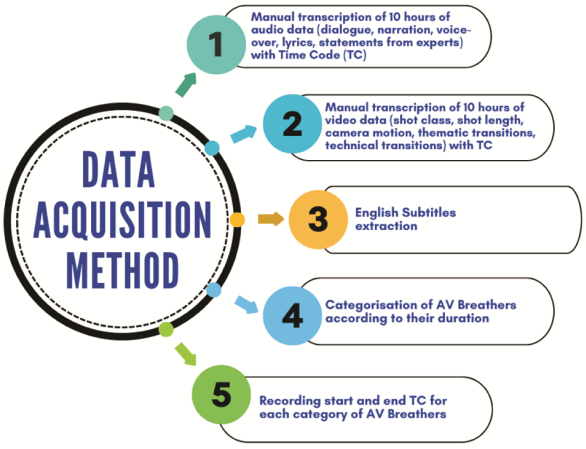

Fig. 1 — Science TV serial *Bharat Ki Chhāp* data acquisition method

Table 1 — Episode-wise break-up of the three categories of AV Breathers and their numbers in *Bharat Ki Chhāp*

Episode	Theme/content	No. of SIs	No. of SABs	No. of LABs	Total
Ep. 01	Introduction	1	3	1	**5**
Ep. 02	The Stone Age till 3500 B.C.	2	2	1	**5**
Ep. 03	The Harappan Civilisation 3500 B.C. to 2000 B.C.	3	1	6	**10**
Ep. 04	The Iron Age 2000 B.C. to 500 B.C	1	2	5	**8**
Ep. 05	The Age of Codification	1	1	7	**9**
Ep. 06	Ayurveda and Astronomy	0	0	3	**3**
Ep. 07	Mathematics and Temple Architecture	2	0	1	**3**
Ep. 08	Synthesis and Growth	4	1	2	**7**
Ep. 09	Stagnation and a Changing World	3	3	3	**9**
Ep. 10	Colonialism and the Industrial Revolution1800 to 1900	2	1	7	**10**
Ep. 11	The Freedom Struggle and the Scientific Community-1900 to 1947	2	0	3	**5**
Ep. 12	Independent India -1947 to the Present	2	0	4	**6**
Ep. 13	Retrospect and Prospect	5	0	0	**5**
Total		**28**	**14**	**43**	**85**

considered as Long Visual Breathers. Song interludes which consistently formed a regular design element in the thirteen episodes of BKC was noted for their number and duration but were not classed into either short or long breathers. The study also took into account other breathers which did not fit into the three methodology categories but worked equally well to help push the narrative through innovative treatment of either video or just the audio or both together.

The study excluded the audiovisual breathers that were of less than five seconds. The methodology did not take into account sound effects, ambience and music. Dramatized sequences were also not counted as breathers for the reason that they served more as extensions to the concept of science and culture presented in various stories and did not typically act as cinematic tools of transition from one sequence to another.

To arrive at the three categories namely SI, SAB and LAB, all the 13 episodes of *Bharat Ki Chhāp* (The Identity of India) were watched on three counts of criteria that had a bearing on driving the narrative. It included the number of audiovisual breathers that each episodes carried (1), their duration (2), and the themes they were based on (3). For obtaining results about watchability ease and the suitability of episode content and comprehension, the open software tool Seoscout was utilized.

Results and Discussion

The mixed method qualitative analysis revealed that 85 audiovisual breathers occupied a total screen-time of 4376 seconds (72 minutes and 56 seconds) across all thirteen episodes of BKC, which included 28 SIs, 14 SABs, and 43 LABs as shown in Table 1. The SIs took the largest share of screen-time at 2712 seconds (45 minutes and 12 seconds), while the SABs occupied the least at 140 seconds. The LABs with a count of 1524 seconds(25 minutes and 24 seconds) were the most significant category of breathers which drove the narrative and struck a balance between core content communication and sustained audiences' attention throughout the stories. The hypothesis of the first author that the percentage of screen-time would be in step with the content density of episodes was confirmed when the ratio of screen-time occupied by all the breathers to the overall duration of 13 episodes of BKC was found to be 11.34% (total duration of AV breathers / total duration of BKC episodes = 72.93/643 = 11.34%).

The total count of breathers in all the 13 episodes of BKC and the episode wise break-up of the number of times the three categories of audiovisual breathers appeared in each episode of BKC is shown in Table 1.

Screen-time Share of Audiovisual (AV) Breathers

The 'percentage share' of the three categories of audiovisual breathers in the BKC, the total duration of each episode and the central ideas dealt therein is represented in Table 2.

Screen-time Share of Song Interludes (SIs)

It was not a coincidence that all the reporters appeared again in the opening sequence of the Episode 02, after having been seen by the river side in the last sequence of BKC episode 01. It was intentionally built as a part of the programme design to establish a continuum with the first episode by

Table 2 — The percentage share of AV Breathers' duration v/s central idea in *Bharat Ki Chhāp*

Episode	Total duration of episode (from title to beginning of end credits) (min)	Total duration of breather (SIs + SABs + LABs) (min)	Percentage share of breathers w.r.t. duration of episode	Central ideas
Ep. 01	48.28	4.57	9.47	Science, People
Ep. 02	48.40	5.22	10.79	Stone, Tools
Ep. 03	49.48	6.93	14.01	Harappan, City
Ep. 04	47.52	6.45	13.57	Iron, People
Ep. 05	48.18	7.80	16.19	Water, Kaveri
Ep. 06	47.92	6.57	13.71	Water, Tank
Ep. 07	48.72	2.92	5.99	Zinc, Temple
Ep. 08	48.63	5.38	11.06	Wheel, Water
Ep. 09	47.53	7.42	15.61	Ship, Science
Ep. 10	52.00	7.93	15.25	Steel, British
Ep. 11	48.95	3.83	7.82	Coal, Energy
Ep. 12	50.72	4.47	8.81	Water, Technology
Ep. 13	56.67	3.45	6.09	Science, Riots
Total	643 mins (38580 secs)	**72.94**	**11.34**	—

keeping the audience engaged not just through the same people but also by choosing to open the episode with a song sung by the same reporters. This is where the role of the audiovisual breathers in providing a link to the next story or idea was clearly established. And the fact that this happened between the first two episodes is a definite pointer of its strategic use.

Opening with a dialogue about what is a city, the song interlude in episode 03 connected the preceding dialogues by anchors and expanded on the concept of cities. Helping drive the narrative here was the technique of integrating dialogue spoken among the actors while the song progressed in episode 03 dealing with Harappan civilization. Though this SI stayed on screen for only thirty seconds, it worked well as a breather because of the connect it provided between the anchors and the reporters who carried on with the narrative by showing the audience outdoor locations where the stories were shot. In contrast to this short SI in episode 03, a rather long duration SI in the same episode was of additional interest for its use of sound track to drive the narrative when a peacock's call is heard along with the ambience of riverside forest mixed with music. The arrangement of these shots during the SI provided for a comfortable transition to the next sequence where the reporters began with the statement "*We'd decided to complete our reports and meet in Kutch*".

Though it was a full two-minute breather about *Brahmastra* right in the opening of the episode 04 which dealt with Iron Age from 2000 to 500 BC, it did not seem to be a drag as it was a song filmed in a theatre which raised a curtain over the theme. Slow track movements on longer dialogue shots helped keep the audience engaged. The conclusion of episode 04 with the complete song filmed entirely on track movements of camera also made for a smooth transition into the next sequence.

The Age of Codification 500 B.C. to 300 A.D. presented in episode 05 was made watchable by time-appropriate placement of the song on the timeline of the episode. The narrative took only ambient audio and video support without taking recourse to the lyrics of a song in order to let the reporters actually reach the place in question. For example, after a general introduction of Sarnath, the anchor walked on a Long Shot (LS) through various nooks and corners of Sarnath, which cut to a tighter shot of Mid-Close Up (MCU) of the top of a monument from where the camera began to tilt down to reveal the anchor on ground who then started to speak about Gautam Buddha preaching his first sermon at Sarnath.

The narrative structure of episode 05 of BKC was also significant due to the use of shots from a museum visit which connected the outdoor location sequence of Shringverpur to the fair of Ekadashi, which thus created the space for the song interlude.

The scientific theme in episode 05 made a transition in the narrative from the subject of hydrological engineering of yesteryears at Shringverpur near Allahabad to talk about bronze and iron through the lyrics of the song with visual transition which started with the shots of farming and villagers engaged in metal work, followed by the shots of Qutub Minar, as well as intricate work on stone, metal coins, cotton and silk. Though the

audience would expect visuals of spices also to be shown at this point because of the demand from the sound track of the episode, their absence made the audience wonder about what would come next to watch.

The episode eight of the serial employed a new technique of the anchor appearing on the scene sounding a *damroo* or *damaru* (a mini drum) to quiz the audience by asking a question about who the person could be. The same technique was used earlier in the same episode, where Al-Beruni and Bernier were hinted at while quizzing the audience. The answer was provided at the end of the quiz which was followed by a song that further extended the narrative. The Song Interlude in episode 11 was taken special note of, when the last shot of the song cut to the monument of Gateway of India where a female anchor appeared to carry the narrative forward. This was followed by a SAB of 23 seconds which consisted of visuals of loading and unloading at Bombay port, followed by the talk about other towns joining in. The creation and placement of this SI was seen as a narrative technique to be executed while shooting science films where maintenance of visual continuity between a specific and an available group of visuals (Gateway of India, Bombay, port) with a larger subject of the same nature (Suez Canal, England, Industrial Revolution) were expected to play a role in making the narrative progress smooth enough while not losing on the attention of audience.

Interestingly, the concluding episode of BKC does away with any SAB, LAB and long SI. Instead, it employed the largest number of SIs (as high as 5 SIs), with the shortest being 23 seconds and the longest being a minute and seven seconds. The SIs were placed on an average of four minutes apart from each other to achieve a time-balance of 56 minutes. The timeline appearance of SIs with key ideas contained in lyrics and the subjects dealt with in the 13 episodes of BKC is shown in Table 3.

Screen-time Share of Short Audiovisual Breathers (SABs)

The SABs in all the 13 episodes of BKC were marked especially on three counts: firstly, when they were the fewest in number (14) and secondly, when they occupied a meagre 140 seconds of screen time in a 10 hour TV serial, and thirdly, when there was no SAB. Five episodes, namely episodes 06, 07, and the consecutive episodes of 11, 12, and 13, were marked by the absence of SABs. It was in these five episodes that other categories of audiovisual breathers compensated. The other findings were that the twenty eight numbers of SIs occupied the most screen time (around 2712 seconds) whereas the 43 LABs were spread out over 1524 seconds as shown in Table 4.

The SABs were crucial in establishing strong visual links between the various visual sequences in order to create transitions to the next idea making the story progress without a thematic, production and post-production execution jumps. A notable instance of SAB was found in episode 05 which comprised of the opening pan shot of sea waves and shore, top shot of palm trees, a Mid Shot of the monument following which the reporter appeared on-screen to visually create the shift from one topic to the next.

Screen-time Share of Long Audiovisual Breathers (LABs)

The duration of breathers in all the 13 episodes of BKC is presented in Table 4. The 43 LABs occupy a total of 1524 seconds (25 minutes and 24 seconds) as opposed to the 2712 seconds (45 minute and 12 seconds) of the SIs. In episode 02, shots of tribals who moved about among vegetation, digging to reach for the roots, community singing by women and preparation of ingredients for cooking provided breathers to appreciate and better comprehend the story. The episode 03 of Hindustan Copper Ltd. featured a 24-second long LAB which consisted of visuals of the factory interiors and an ambient audio-based breather. Shots of fire, camels which passed the scene, bangles made of conch shells, stone shaping, pumping of the bellows and people beating iron into shape provided a variety of shots for audiences' interest to be sustained

The episode 06 took a philosophical overtone when it created an approximately four-minute long sequence (Table 4) talking about 'consciousness' by taking the example of a tree atop which a woman sat and participated indirectly in the discussion. The sequence through live demonstrations on location concluded that "Science is materialist in its philosophy as its concerns are the things of this world". The sequence further brought up the point of idealism being incompatible with science, leading to repeated setbacks to science in our society. The visual breather of Charminar in episode 10 made for the talk on steel to continue. Shots of mechanical movements, still pictures of the 1857 war, monuments of Delhi, locomotives, bogeys and railway engines provided breathers in the stories. Of special mention in episode 12 was the LAB of shots where the reporter was either seen being sailed along the river Narmada or

Table 3 — Timeline appearance of SI lyrics key ideas and their core scientific content in the 13 episodes of *Bharat Ki Chhāp*

Episode	SIs time & Nos.	Key ideas in lyrics	Stories' content
Ep. 01	230 (01)	*Journey of discovery, Bringing alive past ages, Mystery and thrills, unfamiliar, unknown, new experiences, hope, curiosity, imagination, interest*	Pottery, Radiocarbon dating, ancient copper mines
Ep. 02	259 (02)	*First Indians, Who, Where did they live? What did they eat? What techniques did they know? Did they have a language? Stone tools to cut and scrape, Axes to chop wood, Hooks to catch fish! What are such fine tools, if not science? What are they but knowledge?*	Ethno-archaeology, metals, microliths, Neolithic revolution
Ep. 03	268 (03)	*The first cities of Sindhu (Indus) civilisation! What's a city? brick houses, relationships, employment, industries, new thoughts, Surkotada, Banawali, Rakhigarhi, Rehmanderi, Mohenjodaro, Lohumjodaro, Daimabad, Ganveriwala, Rangpur, Dholavira Courtyards, gardens, Kalibangan, Harappa, Chanhudaro.*	Sun-dried bricks, city planning, bronze, copper, agate beads
Ep. 04	201 (01)	*Everything was changing, but this was not the result of great wars, Nor was it the writ of petty kings, Nor the influence of planets and stars, Behind the changes were ordinary things, Like the spread of iron and growing of rice, Power-mad kings emerged, Priests greedy for wealth, revolution under way.*	Harappan axes, grey pottery, iron ore, megalithic culture, Black Polished Ware, vedic geometry, *shulbasutras*.
Ep. 05	248 (01)	*Looking at the stars he said – "This rat to someone bold shall bring wealth untold" A young man heard his words and did what was proper. The flowers they gave him he sold in a trice, Eight coins he earned – a very good price! Wealth increases with the use of brains*	Panini's grammar, Brahmi inscription, *sagarapralokan,* reservoirs and canals, anaicut, *Natyashastra* manuscript, *Arthashastra.*
Ep. 06	0	No. SIs	Ayurveda, Siddhanta astronomy, hydraulic engineering, Aryabhata.
Ep. 07	110 (01)	*How does science grow? Evolving from what things? And how do we absorb the new techniques it brings? Why the gains of a certain age were lost at a later stage? A civilisation that once led fell back, while others forged ahead. Why does this happen?*	Science, new techniques, alchemy, zero, zinc, temples, true arches, domes.
Ep. 08	277 (04)	*A doctor he was, He came from France. He travelled far and wide. You haven't a clue?* *Craftsmen beyond number, able and skilled, they get by on the little they earn, How can they be expected to progress? Given a chance, they will show stunning artistry, beyond compare.*	Trade decline, medicine, paper, agriculture, wooden implements, water wheel, tanks, cloth dyeing, export.
Ep. 09	298 (03)	*Reason dispelled darkness, The earth was not the centre, New ideas ushered in the age of the inventor, Yet the answer is unclear Why did that revolution not happen here?*	Ship building, textile export, trade centres, accurate observations.
Ep. 10	303 (02)	*With the cry of freedom exploded the ferment of '57,And continued to gather strength*	Steel industry decline, iron extraction, iron smelting, surveys, railways, engineering colleges.
Ep. 11	170 (02)	*Science can be used to destroy, But we hoped to use it for progress, We had many dreams when we won freedom, But we speak of what happened before that*	Textile, nationalist scientists, fundamental research, National Planning Committee.
Ep. 12	141 (02)	*On the path of progress, Rahu-Ketu sway us still, What's past is past', but it brought us here, And here is where, we can seize the day*	Independent India, Apsara, Indian Institute of Science, Tata Institute of Fundamental Research, Scientific Policy Resolution, Indigenous technology.
Ep. 13	207 (05)	*Did they sing? Did they hum? Did they have a language? Surely they named their thing, Taught their children what they knew, Who were the first Indians?, All round was a strange disquiet, A revolution was under way, Someone said "Life is an illusion and struggle futile" Someone else said "it makes no difference Good deeds or bad, for good is not rewarded, nor bad deeds punished"*	Exchange with other cultures, remote sensing, science and society, s*hulbasutras*, *ayurveda*, astronomy, ethnobotany, TV broadcast, rockets, strides in electronics and software.

Table 4 — Duration (seconds) of three categories of AV Breathers in each episode of *Bharat Ki Chhāp*

Episode	SIs	SABs	LABs	Total
Ep. 01	230	21	23	274
Ep. 02	259	17	37	313
Ep. 03	268	15	133	416
Ep. 04	201	25	161	387
Ep. 05	248	14	206	468
Ep. 06	0	0	394	394
Ep. 07	110	0	65	175
Ep. 08	277	6	40	323
Ep. 09	298	32	115	445
Ep. 10	303	10	163	476
Ep. 11	170	0	60	230
Ep. 12	141	0	127	268
Ep. 13	207	0	0	207
Total	2712	140	1524	4376

Table 5 — Comprehension of content of science TV serial *Bharat Ki Chhāp*

Episode	Flesch reading ease score	Lexical density
Ep. 01	72	44
Ep. 02	78	45
Ep. 03	72	48
Ep. 04	71	48
Ep. 05	72	47
Ep. 06	70	44
Ep. 07	72	48
Ep. 08	62	53
Ep. 09	66	50
Ep. 10	67	48
Ep. 11	59	53
Ep. 12	66	48
Ep. 13	73	46

having to stand beside to talk about the origin of the river and the natural reservoir it has created near Jabalpur's Marble rocks and harnessing of its waters for electricity.

Watchability Ease Analysis

The relative ease of watchability with which all the BKC episodes appeared to the audience as measured against content complexity of scripts and its screen presentation is depicted in Fig. 2. Taking a dip at episode 6 which is almost midway of the entire episode and having made the audience feel relaxed both with the story subjects as well as its comprehension, the considered design of the TV serial made for an ascend from episode 07 up to episode 11 with more complex scientific themes. The Table 2 clearly establishes it. It was interesting to see the watchability ease analysis curve maintain an

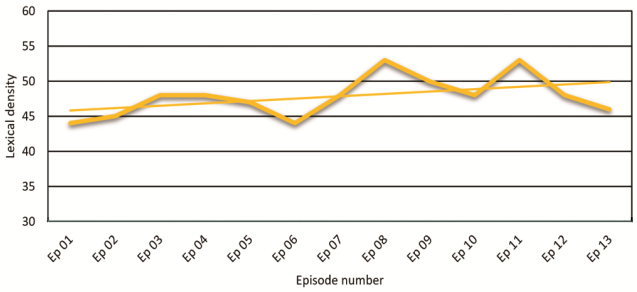

Fig. 2 — Watchability Ease Analysis of all the thirteen episodes of *Bharat Ki Chhāp*

almost flat ascend keeping in conformity with episodes 01 to episode 06, even though the language used in the scripts of episodes 07, 08, 09, 10 and 11 were more complex while dealing with difficult themes that ranged from Shulbasutras to prove Pythagoras theorem using the rectangle instead of a triangle, right-angled gearing, accurate observations for sea voyages, iron extraction from laterite ore, and J. C. Bose's wireless set and light scattering in liquids as shown in Table 5. How easy or difficult it was to follow the English subtitle text through the Flesch Reading Ease Score for each episode is also shown in Table 5. While it is true that there is not much difference in the numerical values presented in Table 5 and Fig. 2, the primary purpose of Fig. 2 is to visually depict the watchability ease for each episode. This visualisation helps illustrate how the ease of understanding progresses throughout the series, showing how the director transitions from simpler terms in the initial episodes to slightly more complex terms in later episodes. Thus, Fig. 2 complements Table 5 by offering an intuitive and graphical representation of this progression, enhancing the overall understanding for readers of English subtitle text.

A point of particular note was the fact of episode 06 that dealt with Ayurveda and Astronomy. The episode progressed from opening of the programme till the end credits without any SI and SAB. It sustained itself on the strength of only 3 LABs with combined duration of 394 seconds which was among the highest across episodes. When compared with the concluding episode of BKC, it turned out that though it was of the longest duration (56:58), it interestingly did not have any SAB and LAB. Instead it was marked by the highest number of SIs among all the episodes. To the author, this appeared as a design decision of the director of the serial, especially when the serial had reached the mid-point of its journey –

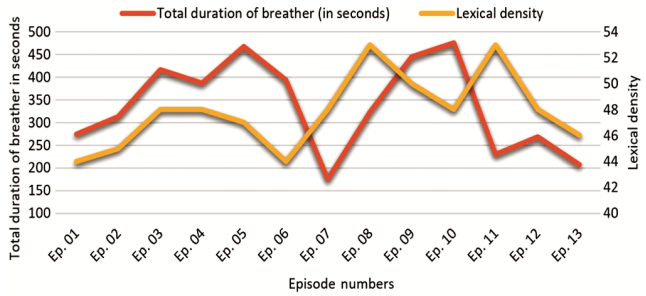

Fig. 3 — Overall lexical density analysis of *Bharat Ki Chhāp* plotted against total duration of Audiovisual Breathers

episode 6 out of the total thirteen episodes. The treatment of BKC episodes thus clearly indicated that for a science television programme to be received well by the audience, crafting relief points both visually and aurally following a content heavy sequence aided better comprehension of the scientific and technological concepts presented in various episodes of BKC.

A general trend that the use of audiovisual breathers established as revealed by the study was its being in conformity with the perceived difficulty in comprehending the scientific and technological concepts as indicated in Fig. 3.

Yet another way of keeping the audience perceive a continuity in the pace of the entire serial was that of 'relatability' which demonstrated itself through the overall analysis of lexical density. The rise and fall of lexical density starting from the opening episode till the time, the serial concluded at episode thirteen, as shown in Fig. 3, consistently moved in step with the increase and decrease of total duration of audiovisual breathers.

Recommendations

Though this study employed manual counting of time codes for all the 643 minutes of cinematic data of the entire science TV serial in order to look precisely at how the visual and aural transition from one story sequence to another took place, a less painful statistical method of quantitative analysis of 'filmic' data called 'Cinemetrics' could be employed by scholars of film studies. The tools employed by the crowd-source platform (www.cinemetrics.lv) yield data to compare styles from different films, filmmakers or aesthetic movements.[12]

Since Cinemetrics is also used to extract camera movements characteristics and identification of movie tempo, it could prove a wonderful tool in the hands of science film scholars to not just identify the specific directorial styles of filmmakers, but also to recognize movie style changes over time, classification of science movie genres and to find common patterns to characterize science and technology-themed films.

Conclusions

While this study suggested that the BKC episodes were not just highly structured in the selection and visual treatment of the content of various stories but it also conclusively established that there existed a symmetry in the pattern of temporal and spatial placing of the audiovisual breathers on the timeline which made the narrative progress in a manner that supported the watchability of the TV serial. It is also found that the denser content balanced itself with an increase in the duration of breathers which enhanced the watchability ease of the entire TV serial - *Bharat Ki Chhāp*. Apart from the sole limitation of counting the time codes manually, the study provided clear pointers for other science filmmakers to apply crowd-sourced statistical methods to cinematic data for analysis of films on science and technology specially when the material is scattered and web-based.

Acknowledgments

The authors would like to appreciate the inputs of Mr. Tausif Ahmed Sayed for graphical representation of statistical data. The unwavering support received from Ms. Anu, a doctoral candidate at CSIR-NIScPR in formatting of the research paper is greatly appreciated as well.

Conflicts of Interest

The authors declare no conflict of interest.

References

1 Rahman M, TV serial & Bharat Ki Chhap explores history of Indian science, Indian Today (1989).
2 Patairiya M K, Science communication in India: An assessment, *J Deliberative Mech Sci*, **4(1)** (2016) 22 –64.
3 Ninan S, Media Pulse, The Hindu, September 20, (1992) 3.
4 Moeller B, Learning from Television: A research review, (Center for Children & Technology), **11** (1996) 27–29.
5 Gellereau M, Jeanneret Y & Le Marec J, Social sciences and the communication of science and technology in France: Implications, experimentation and critique, *Science communication in the world: Practices, theories and trends*, (2012) 109–123.
6 Schiele B, Claessens M & Shi S, Science communication in the world: practices, theories and trends, Springer Science & Business Media, (2012).

7 Van Dijck J, Picturizing science: The science documentary as multimedia spectacle, *Int J Cult Stud*, **9(1)** (2006) 5–24.

8 Belk R, Examining markets, marketing, consumers, and society through documentary films. *J Macromarketing*, **31(4)** (2011) 403 – 409.

9 Gardner C & Young R, Science on TV: A critique, *Popular Television and Film*, (1981) 171–193.

10 The Elegant Universe, (2003), Nova science programming on air and online, https://www.pbs.org/wgbh/nova/elegant/making.html.

11 Rima D A & Michael W A, Special section on history of science in film, *Screening Sci*, (1993)

12 Alvarez F, Sanchez F, Hernandez-Peñaloza G, Jimenez D, Menéndez J M & Cisneros G, On the influence of low-level visual features in film classification, *PloSOne*, **14(2)** (2019) e0211406.