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Screen to science: How moving images impact scientific thinking in young Indian Audiences

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Abstract

Scholarly attention to assess how students interpret the messages presented through moving images and the scientific authenticity of the content treated in films in the context of India is louder than ever before. This paper analyses the impact of short science films themed on grassroots technological innovations and assesses students' comprehension and understanding of science in selected states of India. The paper also explores how students in 74 schools across India appreciate and respond to the scientific concepts and technologies presented and explained in short science films, analysing audience responses by gender and socio-economic background. The results of the analysis suggest that the films on grassroots technological innovations and the manner in which the technologies were presented through moving images positively influenced students' understanding of scientific concepts in both urban and rural educational centres. This paper also addresses the need to engage with scholarly research to establish the impact of short science films on a wider variety of audiences, and the criticality of assessing scientific authenticity while treating content for the production of science films in the context of India.

Keywords: Creativity; Grassroots Innovation; Science Communication; Rural India; Science Films

1. Introduction

As science and its practice have established themselves as an important link in the development process, their absence has also been shown to have hampered many developmental inputs. Developing students' appreciation and understanding of their scientific engagement requires a different set of practices, grounded in a culture of scientific experimentation rather than a purely theory-based understanding of science and its principles. The creation of the education system, leveraging a practical approach to learning, has already become an integral part of the science curriculum. The triad of teaching, learning and practical work has clearly established its logic through the use of the vital tool of experimental design (Robin, 2004).

Situational facts, however much established they may be, often present a flip side as well. Much of what has passed for imparting practical knowledge to students in most government schools in India remains far from satisfactory. Lack of adequate laboratory facilities, combined with easy and sufficient access to the available equipment, are but a few of the reasons. Pareek (2019) conducted a study in 21 secondary schools in Rajasthan, India, and found that the laboratory facilities in those schools were highly inadequate, far below average expectations. In most of the schools, science experiments and assessments of practical work had not even been conducted. A 2014 study by the Unified District Information System on Education (UDISE) and the National University for Educational Planning and Administration (NUEPA) found that more than three-quarters of schools in India lacked fully equipped science laboratories for students. Human Development Data (1990–2017). The inadequacy, therefore, of properly equipped laboratories in most government schools is a problem across all states in India.

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It is precisely here that science films can be actively considered as a rescuer. Visual and aural delivery of science content through moving images has the potential to aid and enrich the theoretical knowledge gained in the classroom. In partnership to address the challenge, the government of India has begun promoting virtual labs across various disciplines of science, engineering, and humanities. The Government of India's National Programme on Technology Enhanced Learning (NPTEL) and Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) provide free online E-learning courses to enhance the quality of education in the country. The courses are themed on subjects taught at schools, colleges, and universities.

Researchers who have studied the public understanding of science have argued that films, television, and new-age, smart devices have had a significant impact in nullifying the distinction between facts, principles, theories, and fiction (Laprise and Winrich, 2010). Films, due to their unique ability to communicate through both audio and visual media, have proven effective tools for engaging with society.

A major challenge that science films routinely face is their ability to draw on the wisdom from a complex array of disciplines, both intellectual and practice-oriented. It is not a single field but a mosaic of several. that spans film studies, artful storytelling, objective research, scripted narration, audio and video engineering, visual and graphic design, graphic animation, audio design and balance, camerawork including shot composition, an optimum shutter speed and iris combination to achieve a well-lit shot, colour temperature matching, editing, music composition, and above all, skilful direction. And all of it is brought to bear on themes drawn from a range of subjects in science and technology, which may be as different as chalk from cheese. Quantum mechanics to genome engineering, metastasis to colloidal solutions, and soft matter to space science could all offer a score of engaging ideas for communicating science through films.

A couple of other concerns about the content being treated in science films stems from three major critical areas - how much and what kind of science should be visualised through films, what impact does films have on public understanding of science, and how the visualisation of science content could leverage from the power of the tools and techniques of production that makes a complex science concept easy enough for quick comprehension. Although science films are proven to be one of the most effective modes of communication, the obvious complexity they entail, combined with questions of aesthetics, narrative style and programme design, has seriously constrained their growth.

A factor that has also paralysed the wider reach of 'development support communication' films is their 'business' aspect. Studies focusing on the business-generating potential of science films in India have been rare. The challenges to science films in India, including emerging technologies, new platforms, and new prospects for content diversification, might be factors to seriously consider while formulating a business and revenue model for the promotion and production of science films in India.

In this study, the interaction of students during and after the screening of films based on grassroots technological innovations that visually present technical solutions to real-life challenges routinely faced by villagers in India has been analysed. The screenings were conducted by the national non-governmental organisation, 'Search for Truth and Return to Science' (START), based in New Delhi, India, which promotes technological innovation and scientific temper. This non-profit organisation comprises academicians, engineers, entrepreneurs, grassroots technological innovators, media professionals, medical doctors, science communicators, scholars, scientists, social workers and technocrats.

The study is based on audience feedback received post-screening on location at 74 schools in 16 states across India. The science outreach non-profit, START (Search for Truth and Return to Science), has focused on public engagement through screening of life-story films on grassroots technological innovations at educational centres across India, especially at under-resourced schools. The films feature informal innovators from India's hinterland. Produced by Television Programme Company (TPC), New Delhi, the short science films on grassroots technological innovations attempt to aid and enrich the learning of scientific concepts. The database of innovators was provided by the National Innovation Foundation (NIF), an autonomous organisation of the Department of Science and Technology (DST), Government of India (GoI).

2. Methodology

This section consists of three parts: data collection, data classification, and data analysis.

2.1. Data Collection

Data analysed in this study include the number of film screenings, the gender of the audience (students aged 9-18), the socio-economic background of the audience, and the audience's responses to short science films themed on grassroots technological innovations.

While the number of film screenings and the socio-economic background of the audience were sourced from reports for each screening, the responses and gender of the audience were curated from feedback forms and location reports for each show. Feedback forms were handed over to the audience after every screening. The forms included questions on- ‘the gender of the audience’, ‘school or institution the audience belonged to’, ‘name and address of the school or institution of the audience’, ‘visual sequences the audiences liked the most in the films’, ‘any new solution to offer for the same problem that the grassroots innovators have already solved’, ‘the weak points in the films’, as well as ‘which films were more impactful than others’

2.2. Data Classification

The data has been classified primarily based on the nature of the films, innovations and innovators featured in the short films and the scientific principles employed and described in the films.

The stories behind the grassroots technological innovation films screened at schools included, among others, remotely controlled fire-cracking machine innovated by Balaram Singh Saini of the state of Haryana, which can be operated with any TV remote, thus preventing accidental burns and injuries; device for preventing accidental locking inside a room, innovated by Gobinda Chandra Gogoi of Assam; “Krishiraja” , a bicycle operated weeder-cim-digger by Gopal Malhari Bhise, a marginal farmer from Maharashtra; the rider and terrain induced bicycle which moves better on pot-holed roads innovated by Kanak Das from Assam; cost-efficient manual wood-cutting machine innovated by Karuna Kant Nath, a carpenter from Assam,; Bullet-proof herbal jacket by Makarand Narayan Kale of Maharashtra; ‘Mitticool’ by Mansukhbhai Prajapati, the son of a potter from Gujarat who innovated a fridge made of clay which functions without electricity and which sells in a number of countries; amphibious bicycle innovated by a honey seller from Bihar that propel equally well both on land as well as on water; exclusively hand-controlled motor vehicle innovated by a motor mechanic, Mujeeb Khan, from Jaipur in Rajasthan who is a lower limb challenged grassroots innovator; highly efficient multi-bladed, double-layered bamboo fan innovated by Nipul and Bipul Bezbora of Assam; a unique light bulb innovated by Prakash Urs from Karnataka which lights up again after it’s filaments disintegrate; pedal- operated washing machine by Remya Jose, a school student from Kerala; world’s smallest electric motorcycle designed and innovated by Santhosh from Karnataka; making music ride over electric current, an innovation by Bora brothers Champak and Trilokya from Guwahati, Assam; and the highly useful innovation of the user verification and distance locking system for motorbikes to prevent theft by Vijay Singh, a grassroots innovator from Varanasi, Uttar Pradesh, India.

2.3. Data Analysis

The responses have been analysed by gender and socio-economic background, revealing a striking difference between them.

3. Results

Over the past twelve years, starting from 2012 to 2024, Search for Truth and Return to Science (START) had screened short science videos in sixteen states across India. These states include Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Nagaland, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal and Gujarat.

START particularly targeted co-educational schools, institutions or educational centres for screening short science films on grassroots technological innovations. 71 out of the 74 were co-educational schools, institutions or educational centres, 2 were all-girls schools, and only 1 was an all-boys school. Figure 1 depicts 61% of the boys and 34% of the girls interacted during and after the film screenings. Interaction included asking questions, answering questions and proposing a problem statement.

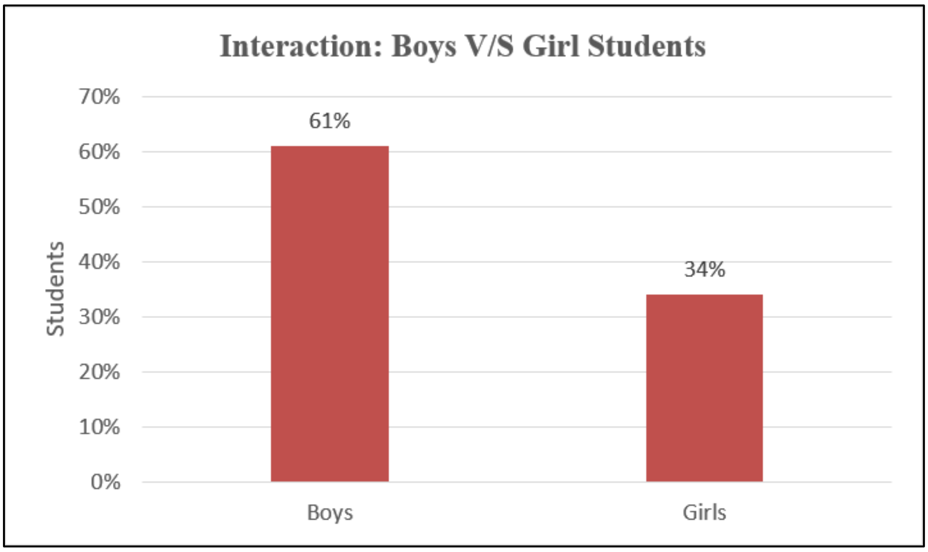

Figure 1 Interaction by Boys and Girl students with the film screenings

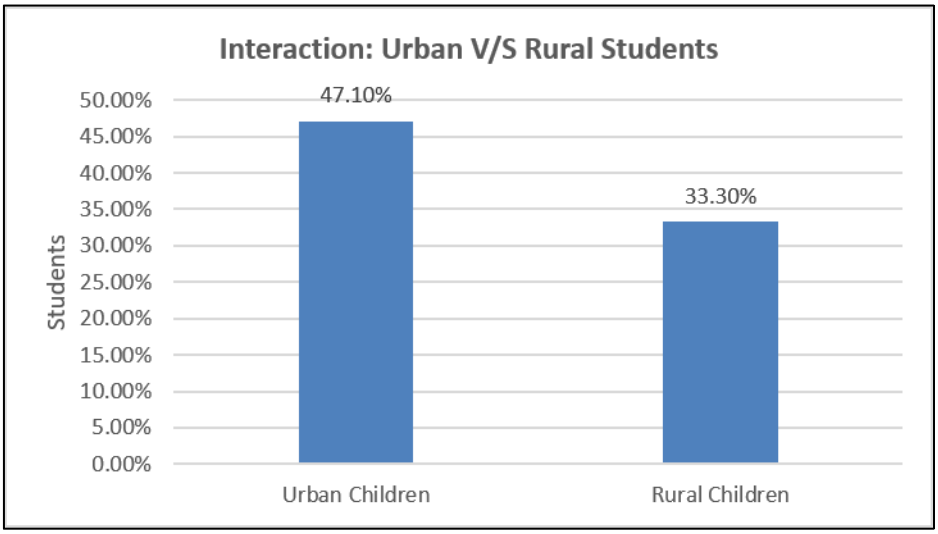

Figure 2 Interaction by Urban and Rural students with the Film Screenings

Figure 2 shows that, on average, 47.10% of students in urban schools interacted during and after screenings, whereas around 33.30% of students in rural schools or educational centres interacted during sessions aimed at encouraging students to speak together. Most students in urban schools were able to understand some of the principles behind the techniques used by grassroots innovators. The students from urban schools were able to answer most of the questions asked by the educator or the communicator in the interaction sessions. They answered the questions based on what had already been taught in their schools. Surprisingly, children from rural educational centres provided sufficiently good responses, though their interaction rate was low.

Upon the conclusion and a long clap after the screening of Mohammad Saidullah's amphibious bicycle at a rural educational centre, a little girl stood up and, without asking, wanted to tell how the bicycle kept afloat and did not drown in the river. "It was the use of empty boxes used as floats which did the trick", she said. Another child hesitatingly whispered that it was the 'blades' attached to the bicycle's frame that also made it operable on the water surface.

In yet another instance, a screening held at a government school in Delhi had participants who lived in utter poverty. Working as 'rag-pickers' in the busy markets nearby, the only lure for them to go to a school was the promise of a mid-day meal where, in the bargain, they received basic education in reading, writing and numeracy. After the films were screened, a few girls wanted to know where they go to learn to create the innovations that they had watched.

A screening at another such school showed how hardship can push people to think in a different way. A boy asked if he could live with one of the innovators, who was willing to accommodate him. Before the screenings, students were given a real-life problem and asked to suggest solutions. They were requested to write down their ideas. Most students took this exercise as a challenge and jotted down their ideas. The problems were based on the challenges innovators faced.

Following this engagement, the very same films were screened to students who were presented with a simple techno-creative solution by the grassroots innovators about which the students had been posed a problem prior to the screening. The science outreach non-profit, START, routinely conducts a session called START THINKING before every screening to encourage the audience to engage in creative thinking. START comes across a number of novel responses during such sessions. The top responses by students of urban and rural backgrounds are shown in Figures 3 and 4, respectively.

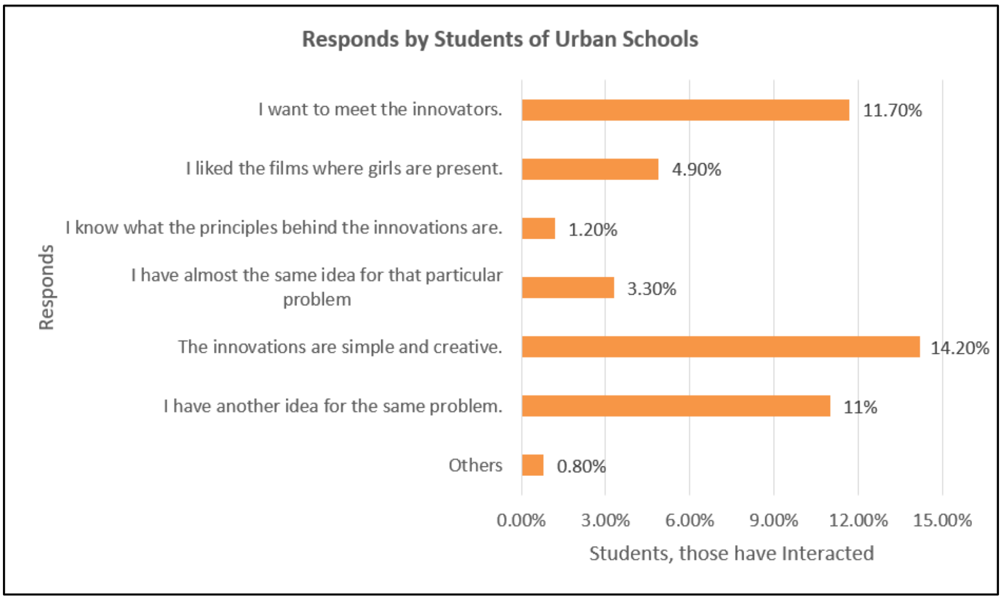

Figure 3 Responses by Students of Urban Schools

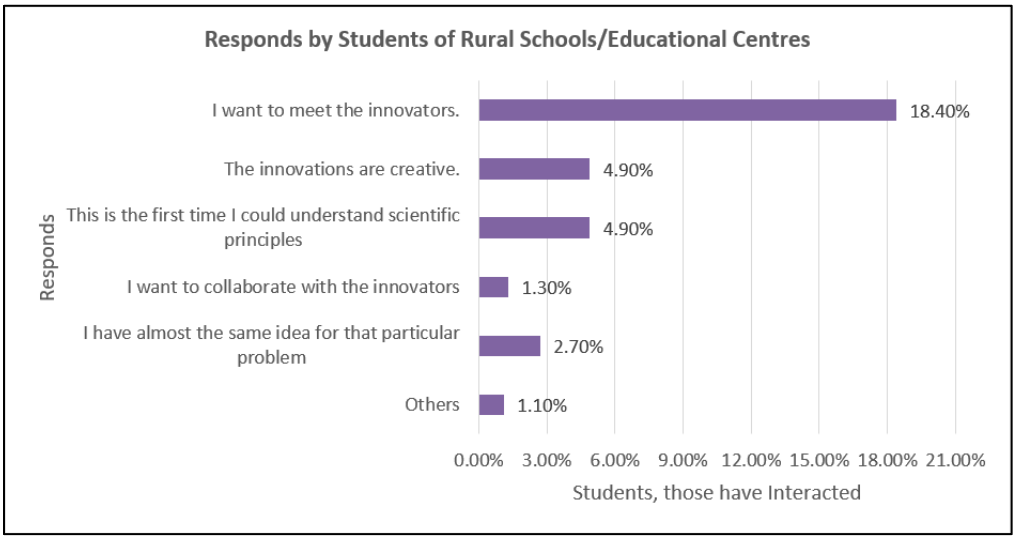

Figure 4 Responses by Students of Rural Schools/Educational Centres

The techno-creative 'thinking' of students from urban backgrounds was quite different from that of students from rural areas. Students in urban schools focused largely on the technologies developed by innovators. Though they found the grassroots technological innovations simple and creative, most students believed they could offer technical solutions to the same daily-life challenges. Some of them even explained how they would approach solving the problem and offered ideas for scientific principles they would employ. While many of the students expressed their desire to meet the grassroots technological innovators in person, the girls liked the short films that featured the innovations by women.

One of the girls, without asking, responded that being a girl may colour her observation, but she quite liked the story of another girl who innovated the bicycle-operated washing machine and wished she were talented enough to think alike.

Contrastingly, responses from students in rural schools or educational centres did not compare well with those from urban schools. Some wanted to collaborate with the innovators, some asked whether they could meet them, and a few said these films made the scientific principles easy to understand. Many of the students also thought the innovations were quite creative, and a few even had solutions similar to those of the grassroots innovators.

Other responses in Figure 3 ranged from students admitting that the films were instrumental in helping them understand certain scientific principles for the first time, to asking questions about the physical principles underlying the innovations, as well as queries related to patents. The observation that the featured stories were inspiring ran common.

Other responses in Figure 4 addressed students' already being aware of the principles behind the innovations, how they could show their work to the concerned person, and the stories' inspiring nature. During a particular screening, one of the girls raised her hand and admitted that, for the first time after watching the grassroots technological innovation of Mansukhbhai Prajapati, she understood the scientific principle behind evaporative cooling.

Indicated below is a sampler of some of the works of grassroots innovators that have been helpful in better appreciation of scientific concepts by the participating audiences during the short film screenings:

- Principle of buoyancy in Saidullah’s amphibious bicycle.
- Evaporative cooling in Mansukhbhai’s clay-cooling fridge.
- Inertia of motion in Karuna Kant’s wood-cutting machine.
- Circular motion and centrifugal force in Remya’s pedal-operated washing machine.
- Electromagnetic radiation in Balaram’s fire-cracking machine.
- Polyethylene and herbal combination in Makarand’s bullet proof jacket.
- Power line carrier communication in Trilokya and Champak’s innovation.
- Circular motion in Gopal Malhari Bhise’s bicycle weeder, and Nipul and Bipuls’ rice husking machine.
- Kinetic and potential energy in rider and terrain induced bicycle of Kanak Das.

Some of the keywords that the students had often mentioned in the feedback forms, while responding to the question - “What did you like most in the films”- varied from content, creativity, hard work, new idea, story presentation, high motivation, to willingness, and close enough engagement.

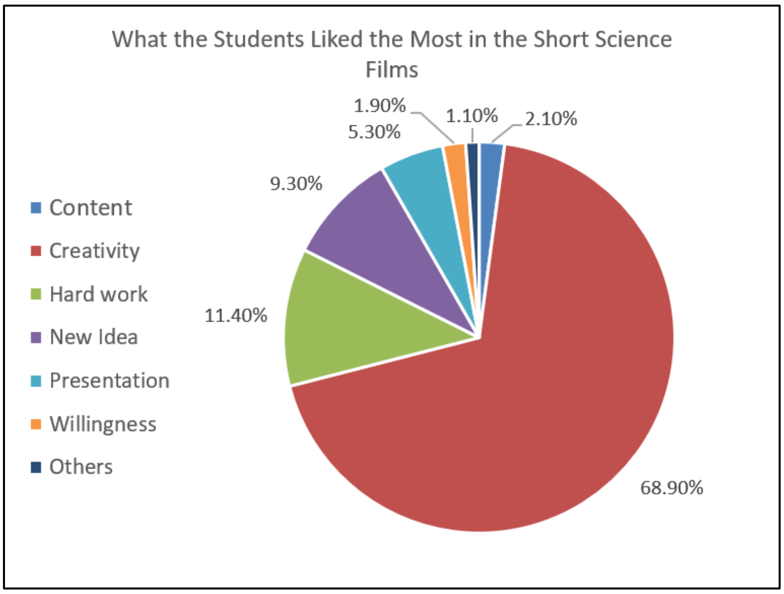

Figure 5 What the Students Liked the Most in the Short Science Films

Figure 5 shows that around 68.90% of students said they were most drawn to the techno-creative quotient in the innovations. While around 11.40% of students mentioned that they were inspired by the innovators' hard work, around 9.30% reported liking the innovators' novel techno-creative ideas. Around 5.30% of students liked the film's storytelling, and around 2.10% liked its content. Around 1.90% of the students noted the tenacity of purpose and the never-give-up attitude of grassroots innovators. The other questions analysed included real-life challenges, rational thinking and demonstrated motivation.

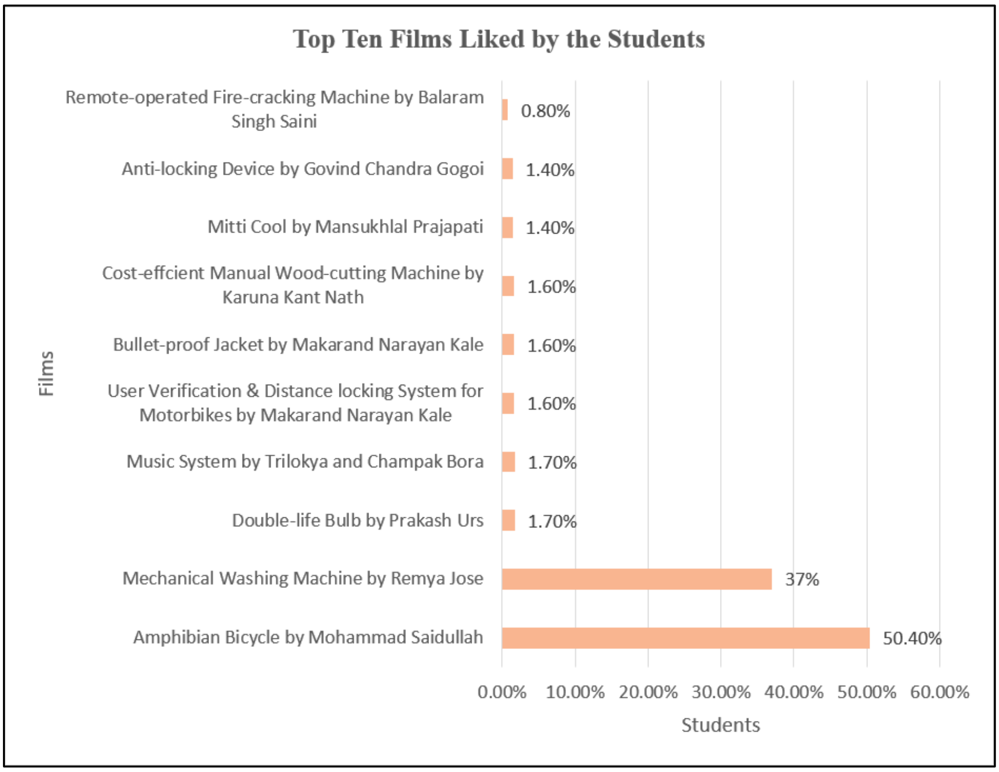

Figure 6 Top Ten Films Liked by the Students

Figure 6 shows the top 10 films most liked by the students. More than 50% students liked the film on the amphibious bicycle by Mohammad Saidullah. Around 37% of students liked the bicycle-operated washing machine film by Remya Jose. 1.70% of students liked the stories on double-life bulb by Prakash Urs, and the same percentage liked the film on multi-location-single-source music feed by Trilokya and Champak. Around 1.60% of students liked the stories on a bulletproof jacket, user verification, distance locking, and a cost-effective wood-cutting machine, separately. The film about the anti-theft device was liked by around 1.40% of students, whereas the same percentage liked the Mitticool film. Around 0.80% of students liked the film on the remote-operated fire-cracking machine.

In each screening, 4-6 films on different grassroots technological innovations were screened. After each screening, the students were asked questions based on the technical aspects of the innovations featured. This session was followed by a discussion on each film, during which the expert present answered the students' questions. This spanned over an hour and a half. The central objective of START was to present the stories of each innovator in a short, crisp, entertaining and informative manner that would hold the attention of the young minds. The films were therefore limited to a maximum duration of 10 minutes. However, TPC also produced documentaries on grassroots innovators, which ranged from 15 to 20 minutes and, in some cases, even longer. Segregating and grouping the videos into categories such as ‘utility’ or ‘transport’, or clubbing together innovations by high school and college students and presenting them to a broad audience, were also attempted. Beyond Bicycle was one such science documentary screened to students in various locations. The film showcased the technological innovations of grassroots innovators and engineering students, all of whom have added value and made suitable modifications to conventional bicycles, turning them into more than just a means to reach a destination. It could pump water from a well, grind spices, charge a cell phone, sharpen knives, drip-irrigate a field, light up a study table, and do chores that normally require the use of a specific machine.

4. Conclusion

The results showed that short films on grassroots technological innovations fostered a positive attitude among school students towards receiving scientific content, especially in appreciating and understanding the scientific principles explained in the films, which paralleled those in the school science textbooks.

The analysis also established that students from rural backgrounds and low-resource settings had questions about how they could meet the innovators featured in the films and whether they could work with them. This aspect of the analysis points to a much deeper introspection into such responses. Though their social insecurities could be an overriding reason, it is equally difficult to discount the fact that they are ambitious enough to try things that may seem risky to people who do not share the same challenges. Even warming up to making a decision about their future career or vocation could be their best shot at altering the status quo that shapes their microcosm and serving as a beacon for others in their immediate communities to venture into newer directions.

The students' responses also indicate that the visuals were understandable to students aged 9 to 18. Irrespective of this quite high span, the responses were homogeneous throughout. Some students even stated that the film screening helped them understand the science behind the concept of cooling taught in physics classes for the first time.

In another study conducted at Mersin University, Turkey, on the impact of science fiction films on the student interest in science, it has been shown that the students stated that viewing the films and identifying the scientific concepts, beliefs and pointing out the delusions in the films by the educators were helpful in understanding the course concepts (Laprise and Winrich, 2010).

An analysis revealed the need for a closer examination of how the impact could be gauged if the audience composition changed from school students to adults on the one hand and trainers on the other. The trainers of other participating NGOs who attended the screenings along with their students, as well as teachers who accompanied the students from some of the schools, also formed a sizeable part of the audience when all the screenings are assessed together. Varying audience profiles ranging from students, trainers and teachers, and the impact a science film makes on them could be a worthwhile future study.

A factor that made these films visually rich was the fact that the innovators came from disparate professions. Being a carpenter, cobbler, cooking gas cylinder vendor, clerk, electrician, motor mechanic, para-military personnel, school teacher and watch repairer whose life experiences were their inspiration and the backyard of India their laboratories, made the films all the more watchable.

Though the production of science films in India is looking up, with the numbers increasing in recent years, scholarly studies on them will take a long time to catch up. This is not just typical of the films produced over the last couple of years; it is also true for science films produced in India during the 1980s and 1990s as well. All the more reason that scholarly attention is focused on assessment of not just the impact of science films produced in India on the public understanding of science in the country and the validation of scientific authenticity of the content treated in the films, but a deeper look into a range of aspects of ‘production’ and ‘post-production’ handling of science films made in India over the past three decades is also sorely required.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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