Bewitching Books: using technology to add magic to picture books

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Premise

Picture books introduce children to wondrous new worlds where thoughtfully crafted images enable them to expand their imaginations. But what if those images could move? How would they help tell stories better?

For the longest time technology has been looked at as something that reduces attention spans and diminishes traditional reading experiences. So, it's easy to look at it as an adversary. However, in this paper we discuss how technology can be used to reach more readers and develop new ways of storytelling.

Writing and illustrating are inherently creative processes and it's easy to dismiss the involvement of technology in them. However, fresh illustrating techniques and styles have evolved out of the use of computers, access to millions of children has been made possible and, in Pratham Books, new storytelling techniques have emerged -- like our GIF (Graphics Interchange Format) picture books. In these books, with the help of technology, we were able to bewitch picture book illustrations and make them move and dance as GIFs.

The looped images make the books come alive by creating an immersive experience. We put this to test by choosing to tell three stories using GIFs. We will elaborate on how we went about picking stories, illustrators and art styles best suited to this unique format. We will also discuss what technical specifics were involved in making sure that the

GIFs would load quickly on our digital content platform StoryWeaver even on a low speed internet connection, with minimal loss of quality. We examine how these books and other unique formats reach even the most reluctant of readers, a lot of whom don't have access to books and technology freely.

1. The joy of reading

Give a child a book, and you are giving them the most advanced technology. A book allows a child to travel to places, both real and imaginary, to inhabit the lives of people vastly different from their own lives, and to encounter ideas that they may not have a chance to, in their immediate environment. Reading shows children what the world is like and gives them the tools to imagine what it could be. In addition to developing literacy and language skills [1] and contributing to mental well-being [2], reading from a young age develops empathy and understanding [3]. It helps create open-minded and kinder adults.

However, a significant number of children in India, and across the world, don't have access to books at home. Of the 387 million primary school-age children unable to read proficiently, 262 million (68%) are in school. A primary reason for this gap, as per a UNESCO report [4] is that children should be taught in a language they understand, yet as much as 40% of the global population doesn't have access to education in mother-tongue languages. Already dire, the situation has worsened during the global COVID-19 pandemic we are facing right now. As of mid-April, 1.5 billion children and youth across the world had been at home as schools and colleges were closed [5].

Making sure children have books they can afford, in languages they understand, and ones that are engaging and relatable, is a significant step towards spreading the joy of reading.

It is with this idea, to spread the joy of reading to *all* children, that Pratham Books was set up in 2004.

Pratham Books is an Indian nonprofit publisher of good quality, multilingual picture books. Picture books, meaning books where words and pictures work together to tell a story, are typically made for young readers. The mission of seeing 'a book in every child's hand' makes clear the goal of the organization, which is to support book access by producing books that are available at a low cost, are set in a context that is familiar, are published in mother-tongue languages, and, most importantly, have words and pictures that draw readers in.

The way this is ensured is by working with a robust network of some of the best editors, art directors, writers and illustrators in the country, through a process that is cognizant of the needs and reading habits of our readers, especially the most disenfranchised ones.

Since its inception, Pratham Books has published 5000 books in 24 languages.

2. Climbing the mountain

Imagine a place full of books, located on top of a mountain. No one lives there but anyone can climb the mountain. Now imagine that some people have helicopters to fly them there whenever they like. Others have cars or very good hiking boots. But there are some who have no shoes, and still others who cannot walk.

So how do we make sure everyone can climb the mountain?

For a large part of the world's population, books are not a privilege they are able to enjoy. When they first encounter books, it is in school and their ability to read is not at par with other children their age, and the books are either only academic or too challenging. According to the Annual Status of Education Report (ASER) of 2019, 21% children in Std I of government schools could read words as compared to 46.7% children in private schools – an advantage of 122%! [6] A big part of ensuring book access is creation, but the other major part is being able to get these books in the hands of those who need them most.

3. Enter StoryWeaver

To this end, in 2015, Pratham Books launched StoryWeaver, a digital platform that publishes richly-illustrated, multilingual books for free, under the most liberal open license, CC-BY 4.0. This licence allows books on StoryWeaver to be completely adaptable to users: they can read, download and print books, they can translate or relevel books, and they can also create their own stories. Its core mission being that of inclusion and erasure of boundaries, StoryWeaver is a multi-publisher platform with books from publishers like Room to Read, Book Dash, and translation partners like African Library & Information Associations & Institutions, Darakth-e Danesh Library, Konkani Bhasha Mandal, among others.

In five years, StoryWeaver's repository has grown from 800 books in 24 languages, to over 27,000 books in 280 languages, with a readership of 50 million and users from 150 countries: 57% of languages featured on the platform are indigenous, 12% of the languages have been classified as vulnerable or endangered by UNESCO.

The impact of StoryWeaver is being realised in a dramatic way now, during the pandemic. In the initial months of lockdowns and school closures, from April to June 2020, the StoryWeaver user base grew by 150% over the previous quarter, with increased proportion of traffic from early COVID-19 impacted countries in Europe like Italy, France, Spain. In Italy, for instance, we saw users creating stories to help them cope with their situations, like that of a lonely tree in an isolated garden, or of a child who is forced to stay home because of a mysterious virus.

Pratham Books was awarded the 2020 David M. Rubenstein Special Response Award by the Library of Congress for its impact during the pandemic [7].

4. Glued to the screen

The increased availability of low-cost smartphones in India since 2010 has created the right conditions for digital adoption and literacy to grow. In 2018, at 483 million users, India had the world's second largest internet population, of

which 81% of these users accessed the internet through their mobile phones [8]. From 2018 to 2020, the proportion of households owning a smartphone increased enormously – from 36.5% to 61.8% [9].

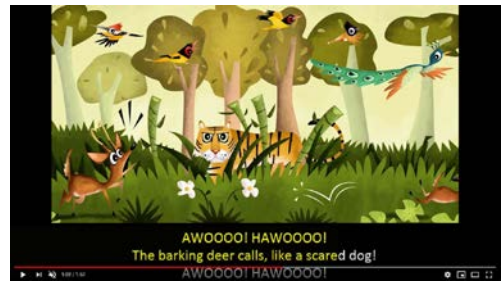
Pratham Books has found that over 60% of all consumption of StoryWeaver is on mobile phones. Keeping this in mind, we wanted to explore different ways in which a story can be read and enjoyed on mobile phones.

One of our first forays into these explorations were PhoneStories [10], which were launched in November 2017. Containing subtle animations which make the illustrations gently move through the story guided by a narrator, this set of four stories were meant to be easily shareable in a video format.

Telling stories about wildlife, the books used visuals and sounds to make the books engaging for younger readers. A callout to the community resulted in people sharing actual forest and bird sounds and releasing them under the CC-BY licence out of sheer goodwill. These were used in titles, *Watch Out! The Tiger is Here!* and *Did You Hear?* Readers who might not get an opportunity to visit a forest, could experience it come to life on their screens. Books have always had the ability to be able to transport us to new and unexplored places. But technology can be used to take this ability to the next level.

By collaborating with literacy organisations and government schools, we were able to reach 2,800 schools/centres and teachers, resulting in over 56,000 children reading these stories via WhatsApp.

Encouraged by the success of the audio narrations in PhoneStories, StoryWeaver launched Readalongs in September 2018. Available in four languages, these are audio-visual storybooks with subtitles that mirror the audio narration, allowing early readers to listen to as they learn to read. Readalongs and are used by educators to help early readers build language and pronunciation skills. They have been viewed more than 4 million times and, given the demand, efforts are being made to make Readalongs available in more languages.



A still from the video of the first of the PhoneStories, Watch Out! The Tiger is Here! (written by Sejal Mehta, illustrated by Rohan Chakravarty)

With PhoneStories, we were able to introduce motion into storytelling. However, it has been observed [11] that too many interactive elements sometimes take away from the narrative itself and reduce story comprehension. What we wanted to do was combine the appeal of watching a video with the intimacy of a traditional reading experience, so it would feel like reading a magical book.

5. The GIF of movement

That ideas come from unexpected places is not just a platitude. The team that worked on these books (led by Bijal Vachharajani, senior editor at Pratham Books) is often known to have entire, rather complex, conversations only using

GIFs. It was one such conversation that led to the idea that the singular enjoyment provided by the limited but expressive movements of GIFs could be combined with the joy of picture books.

The intent behind GIF books is to make the digital reading experience a uniquely enjoyable one. It's no secret that human eyes are drawn to colourful, moving images. To use that tendency to get a child to read a book was an idea that held appeal, especially for us, knowing that so many of our readers are reluctant and approach a book tentatively. Moreover, since many of our books are accessed digitally, we wanted the readers to know that digital reading was not a compromise. We did this by giving them something that they could not get from a physical book.

GIF books are just like picture books, except that the pictures move. By using an image in the GIF format, instead of a stationary image, we are able to enchant the book to make the reader want to turn the page. The pictures in the books contain specific repeated movements, so we avoid losing the essence of reading a book. Readers can still turn the page at their own pace, spending time poring over the text and enjoying the images.

5.1 When we read, we begin with G-I-F

We decided to create three GIF books, in five languages each. This was the first time something like this was being attempted, so selecting the right scripts was very important.

We wanted to pick stories that would work across different age groups, and appeal to readers with varied interests. However, we did want to make sure that they would lend themselves to this format. Since GIFs are all about movement and magic, the three books needed to contain these elements. We wanted the books to have a universal appeal, so we reached for the most universally beloved children's book quality: humour.

Gappu Can't Dance [12], written by Menaka Raman and illustrated by Krishna Chandran, is about a girl who keeps getting her steps wrong in a dance class. When everyone in class raises their right hand, Gappu raises her left. Using sounds and movement, this book tells a story about self-acceptance and embracing your differences. So, to be able to see and dance along with these wide-eyed children, and to see Gappu doing the opposite of what the rest are doing, enhances the experience of reading the book.

The Big Book of Boochandis [13], written by Pavithra Sankaran, illustrated by Rucha Dhayarkar and art directed by Somesh Kumar, is about Indian folkloric monsters called boochandis. Through irreverent rhymes, the book introduces readers to a cast of wildly different boochandis who live all around them, if only they would notice. And what better way to get them noticed than by watching them move in and out of the frames and wiggle their bellies.

Shoecat Thoocat [14], written by Shalini Srinivasan and illustrated by Aindri C., is the story of the relationship between a girl and Shoecat, an alien that crashes into a tomato field. It's a droll fantasy that is both amusing and unsettling, often at the same time. The use of GIFs here was able to heighten the otherworldly feeling of the story. Whether it's the Shoecat's iridescent fur, or the green glow left by its

scratches, the GIFs in the book immediately give the reader the impression that this is no ordinary book.

5.2 Drawing out the GIFs

Once the three titles were selected, we had to figure out who would be the best illustrators to bring these books to life. We considered the following:

- An illustrator with animation skills
- An illustrator who would be able to consider movement while creating the illustrations

The brief given to the illustrators was to emulate the effect created by a cinemagraph. Cinemagraphs contain subtle motion that plays in a short, never-ending loop, while the rest of the image remains still. It would also be important for the illustrators to seamlessly loop the GIFs, so as to avoid creating a distracting reading experience.

We approached Krishna Chandran, a talented illustrator and animator to illustrate *Gappu Can't Dance*. In this book, it would be important to convey the dynamism of Gappu's movements. The movements would be simple - up/down, left/right, in/out and, since this is a character-based story that strongly revolves around human emotions, the characters' expressions would need to be suitably animated as well. A slight frown, a raised eyebrow, a wide grin: with these simple animations, the book and its characters could grow beyond the screen.

This illustration was originally published in ' Gappu Can't Dance' by Pratham Books. www.prathambooks.org.

Next, we asked Aindri C., a prolific illustrator and GIF maker to illustrate *Shoecat Thoocat*. The animated elements ranged from the wavy gas cloud released by the shoecat and the green glowing trail that followed it, to the dramatic shattering of pickle jars and light bulbs. When the Shoecat would howl, the 'OOOO' would be made to move across a page. The animations in this book would focus less on movement, and more on creating an eerie atmosphere using elements in the environment.

This illustration was originally published in 'Shoecat Thoocat' by Pratham Books. www.prathambooks.org.

Lastly, we approached clay artist Rucha Dhayarkar to create wonderfully weird creatures for *The Big Book of Boochandis*. Since the characters were to be made out of clay, they would be brought to life painstakingly through claymation. We wanted their movements to be subtle and humorous to support the text.

This illustration was originally published in 'The Big Book of Boochandis' by Pratham Books. www.prathambooks.org.

The illustration process has a number of stages and includes a round of feedback and discussion at each stage.

- Character sketches
- Storyboard/thumbnail sketches
- Rough sketches
- Final artwork

At Pratham Books, the artwork is always created for printed books, and then adapted to a digital version for StoryWeaver which has a different set of templates.

First, all the artwork is converted from CMYK (print) to RGB (digital). Then there is a round of colour editing. Each image is then resized in order to fit the template exactly and avoid cropping. This usually involves altering the image in subtle ways so that it is the best version to fit in the template, while retaining the essence of the illustration and story as a whole. The images have to be a minimum of 150 PPI (pixels per inch) and in the JPEG/PNG format. This is to ensure that the image can be resized in different layouts, without compromising the quality of the image. The images are then uploaded on the site, the text is added and the story is published. This template (now called a digital master layout) is shared with editors of the other languages for typesetting in those languages. Once published, the story can be read on StoryWeaver and even downloaded as a printable PDF or ePub.

The process in the case of the GIF books would be different as we would be working with GIFs instead of static images. So, there were two main elements to be considered when thinking of the outcome of the books themselves:

- GIFs on the StoryWeaver platform
- Downloadable PDF/ePub

5.2.1 GIFs on the StoryWeaver Platform

StoryWeaver is built on Rails, a web application framework with ReactJS as its front-end technology. The third-party libraries used are open source. The most active codebase is released under the OSI-approved MIT license, one of the most liberal licenses. All the code is on GitHub where anyone can view and participate in the further development of StoryWeaver.

Pratham Books has a team of developers and technical advisors who analyse requirements and assess the possibilities as well as limitations of the platform. We worked with them closely on this project.

As a part of the art process, illustrators are usually given a time frame of 2-3

months. While they started the process of creating the illustrations, we began testing a random selection of illustrated GIFs on our test site. In order to do so, we collected samples of different kinds of GIFs, with varying sizes and illustration styles.

Then we did a preliminary study of the GIFs. We noticed that the larger GIFs weren't necessarily of a better quality. The 1.2 MB GIF was just as good as the 45 MB GIF in its appearance. Upon researching further, we found that GIFs have different parameters to consider when it comes to optimization. Some of these parameters and their implications are:

- Image size

  A larger image size would lead to a larger GIF, which would take longer to load on the StoryWeaver site and create an unbalanced reading experience.

- Number of frames

  A range would need to be established to manage the size of the GIF.

- Number of colours

  The GIF format allows only 256 colours in order to manage the size.

- Dithering

  While dithering, a technique that improves the colour transitions and overall appearance, could be used, care would have to be taken to keep it as low as possible to maintain a low size.

Next, we moved on to testing. We started with uploading the following GIFs, keeping size as the only variable:

- Extra small size (119 KB)
- Small size (1.2 MB)
- Medium size (6.1 MB)
- Large (45 MB)

GIF size	*Appearance on screen*	*Upload time on testing site*
119 KB	*Unclear, pixelated*	*Low*
1.2 MB	*Very clear*	*Low*
6.1 MB	*Somewhat clear, slightly pixelated*	*High*
45 MB	*Very clear*	*Did not load*

Table showing results of GIF testing

Based on these tests and further trials, the tech team was able to narrow down the limitations of the platform to the following:

- GIF size

  It is crucial that the load time of a story is low, so that the reading experience isn't hampered. If the images load too slowly, the reader might lose interest in the story. Since it is important for our books to reach as far as possible, we had to consider remote locations, and therefore slower internet speeds. Hence, a size limit of 2 MB was imposed, as that is the acceptable limit for a static image upload as well.

- Number of frames in the GIF

Reducing the number of frames reduces the GIF size most drastically. Hence, it was suggested that the illustrators stick to a range of 8-12 frames, keeping the number as low as possible without taking away from the quality.

- Minimum frame size

Each frame was to be at least 4 KB, and the image could not contain transparent colour in any of the frames as that was leading to the GIFs not being able to get uploaded during testing.

- Number of GIFs in a single story

The number of GIFs in a story was limited to 20 since it was anticipated that a number larger than that would lead to severe delays in the loading of the books during reads and also while downloading. Hence, all three stories were paginated to be less than 20 pages.

- GIF as the cover

Since the GIF books would be sharing the same space as the non-GIF books on the site, it was decided to not have the cover animated, since that would distract from the other stories. Instead, the books would be indicated by the word GIF which would be seen when hovering over the story cover image.

- GIF dimensions

When starting with a dimension, 1073 x 771 for the horizontal layout and 745 x 1100 for the vertical layout was recommended. However, it was found that it resulted in a larger GIF size than desired (>2 MB). Further analysis was done to determine what would be a good trade-off between size and resolution. Hence, there had to be specific resolutions for GIFs (or as close as possible to it) to fit the whole page template. The final dimensions, based on the text-to-image ratio in different StoryWeaver templates, are listed below:

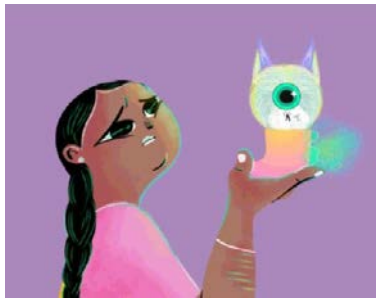
Orientation (Text x Image)	*Dimension (pixels)*
Horizontal Layout	
1. Side x Side (50 x 50)	*391 x 561*
2. Top x Bottom (66 x 33)	*775 x 373*
3. Side x Side (66 x 33)	*516 x 560*
4. Top x Bottom (75 x 25)	*775 x 420*
5. Full Image (100 x 100)	*775 x 560*
6. Top x Bottom (33 x 66)	*775 x 373*
7. Full Image (100 x 100)	*775 x 560*
8. Full Image (100 x 100)	*775 x 560*
Vertical Layout	
1. Top x Bottom (50 x 50)	*415 x 306*
2. Bottom x Top (33 x 66)	*415 x 408*
3. Top x Bottom (50 x 50)	*415 x 408*
4. Full Image (100 x 100)	*415 x 612*
5. Top x Bottom (50 x 50)	*415 x 459*

Table showing final GIF dimensions for StoryWeaver

Once these parameters were finalised, they were shared with the illustrators. Horizontal templates were chosen as they would be closest to the print version, which consisted of landscape format images.

We had to go through multiple rounds of discussion with the illustrators, and several rounds of testing of the GIFs with the tech team. Since all the animated GIFs were created on Adobe Photoshop, we were able to look at the number of frames, as well as export options, which included the number of colours and dithering.

However, in the case of *Shoecat Thoocat*, the illustrator Aindri exported the GIFs as a series of frames rather than a .MOV file, took it to GIMP and converted it into 10 frames instead of 24 frames.



Before (24 frame GIF exported from .MOV file)

After (10 frame GIF exported from frames as a sequence)

An unexpected thing we found was that a textured style ended up disguising the artifacts, making them look more natural. An artifact is a noticeable distortion in the quality of the GIF brought about due to data compression.

The GIFs for *Gappu Can't Dance*, for example, were illustrated in a very textured style, which hid several artifacts. A low average frame rate of 4/sec also led to fewer artifacts.

In the case of the Boochandi GIFs, art director Somesh's decision to use flat white backgrounds instead of detailed ones made the GIFs look cleaner.

By playing around with the many variables mentioned earlier, we were able to achieve good quality GIFs with minimum artifacts and of a reasonably small size that loaded quickly on the testing platform.

5.2.2 Downloadable PDF/ePub

Once a book is published on StoryWeaver, readers can also download it in the ePub format and as a printable PDF. This enables a book to be printed and distributed, allowing it to be read without an internet connection. Usually how it works is when the download button on the story is clicked, the images in the story are automatically populated into a PDF/ePub template and then downloaded to the device.

The process was smooth for the ePub format, since it would display GIFs on all devices. However, the PDF would have to be populated with static images from the GIF source. So, the process would once again have to be slightly different.

Initially, we planned for the PDF template to be populated with the first frame of the particular GIF since most PDF readers

automatically do that. So, it was communicated to the illustrators that they should arrange their frames in such a way that the first frame would work as a standalone illustration as well.

When the final GIFs were ready, we started testing them on the StoryWeaver site. However, no matter what combination of varying parameters (resolution, size, number of frames, etc.) we tried, the still images on the PDF appeared to be pixellated and we were unable to pinpoint the exact reason.

So, we decided to upload static images separately. This way, when downloaded, the PDF would be populated with the aforementioned images instead of a frame from the GIF. At last, the PDF looked good and did justice to the reading experience.

5.3 Moving books

The GIF books were launched on Children's Day (November 14, 2018) amidst much fanfare, and were an instant hit. Several media outlets wrote about these books [15,16] and *Gappu Can't Dance* quickly became one of our most read titles. The books have been translated in over 15 languages and read over 46,000 times. Since then, several more GIF books have been created, and can be read for free on StoryWeaver.

During reading events, the moment the first page loads, and the children see that the pictures in the book are moving, they let out a collective gasp. These moments of awe and wonder are what drive us to dream up new ideas.

Children dance along with Gappu and author Menaka Raman during a school event

Conclusion

Storytelling using pictures is an art form that has endured for generations, and will continue to do so. However, its timelessness does not obviate its ability to transform. Hand in hand with technology, we can extend and reinvent the scope of what a picture book can do: whether it's in terms of how far it can travel and how inclusive it can be, or the form of the book itself.

At Pratham Books, we want to enable young readers everywhere to enjoy reading because we believe that stories have the power to change lives. A reader has immense independence: they read a story at their own pace, linger over images and words, place themselves in a story or even make the stories a part of their world. Our GIF books, as with all our innovations, have been created to further this idea, while maintaining the sanctity of this independence. What sort of picture book experience could we cook up if we were to sprinkle some virtual reality, or a dollop of artificial intelligence? Given the astonishing pace at which technology is developing, GIF books are surely just the beginning of what's possible.

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