**Article QR**

| | |
|---|---|
| **Title:** | ***Khel Tale*: An Interactive Animated Storybook App for Children** |
| **Author (s):** | Fatima Mujahid |
| **Affiliation (s):** | Founder and Chief Designer Officer (CDO) at Sivisic.com |
| **DOI:** | https://doi.org/10.32350/jdt.12.05 |
| **History:** | Received: November 16, 2022, Revised: November 28, 2022, Accepted:  December 14, 2022, Available Online: December 31, 2022 |
| **Citation:** | F. Mujahid, "Khel Tale: An interactive animated storybook app for children," *J. Des. Text.*, vol. 1, no. 2, pp. 71-96, 2022, doi: https://doi.org/10.32350/jdt.12.05 |
| **Copyright:** | © The Authors |
| **Licensing:** | This article is open access and is distributed under the terms of Creative Commons Attribution 4.0 International License |
| **Conflict of Interest:** | Author(s) declared no conflict of interest |

# *Khel Tale*: An Interactive Animated Storybook App for Children

**Fatima Mujahid**[*]

Founder and Chief Designer Officer at Sivisic

## Abstract

According to the current study, children adores reading fairy tales or comics since their childhood. In today's world, digital grounds have transformed storybooks into animated illustrations. In particular, famous studios like Disney are producing movies out of them to attract and influence millions of children. However, moral based stories have always been in demand to teach children that how to pay heed to the elder's advice. Also, how to morally transform their behavior in a positive manner. *Khel Tale* is a modern version of animated storybook application for children to play which asks them to pick one of the main characters of their own choice, out of the story. Thus, children enjoy the consequences of making those choices at the end of the story. It is a choice based animated storybook that plays 3D animation clips in order to narrate the whole story to children through pictorial illustrations. The main purpose of this mobile application is to teach children regarding the importance of obeying the instructions of their elders through decision-based 3D animated stories. The application runs in landscape mode and is divided into further episodes. The content of each episode covers a small lesson for children. An episode begins by playing a fixed 3D animation video clip, and later on it offers two choices to children in order to particularly conclude the episode either with a good choice or a bad choice. Later, children can also see the consequences of their choices and actions in the story. The basic concept of this application revolves around a thought that mostly children are fascinated by the characters they observe in cartoons and read in stories. Hence, they start relating them to those characters. This concept is evolved by combining the approach of teaching to children through 3D animated stories where they can choose the characters to see the reaction of not listening to their elders. They also observe that what reward they can get if they actually act patient and listen to what elders advised them. Hence, the current study regarding *Khel Tale* application concludes it with the effectiveness.

---

[*]Corresponding Author: fami1698@gmail.com

***Index Terms:*** Animated storybook, audio dubbing, computer animations, *Khel Tale,* teaching good behavior*,* 3D and 2D visual models

## I.   Introduction

The current study claims that one of the most prevailing issue around us today is that children seldom pay heed to their elder's advices. These days children possess "know it all" behavior which makes them think that they already know everything. In reality, children lack basic understanding of the real-world problems which causes troubles for them as well as for their parents. Most parents consider yelling and scolding as an effective measure to make their children listen to them, which is an aggressive behavior and should be avoided. In reaction to this aggressive behavior of the parents, children are not fond of listening to their instructions. Also, they show resistance to the lectures given by their elders and mainly act stubborn [1]. Thus, the disobedience of the children becomes a problem and struggle for their parents.

Moreover, parents always guide their children by giving them the real-world examples. They often make them aware of the consequences of neglecting the elder's advices. Despite that children still ignore those instructions. Anyhow, the main reason of doing this is that they are young and they lack experience. The experience and maturity are gained with the passage of time or when a problem is faced practically. Children love watching animated stories as they are easily influenced from their favorite characters [2]. While imitating those characters, they try to talk, dress, and even act like their favorite animated toon characters. Hence, the process becomes even easier for children to learn if they can directly relate themselves to the characters they watch; and observe in an animated video.

### A.  Mobile Application

*Khel Tale* is a modern 3D animated storybook mobile application for children which allows them to make choices of the main character out of that specific story.  It further allows them to see the consequences of those choices they have made inside the story while playing that game. Moreover, it is a choice based animated storybook that plays 3D animated clips to narrate the moralistic stories to children. Its main purpose is to teach children regarding importance of obeying instructions given by their elders through decision-based 3D animated stories. Furthermore, it is a mobile application that runs in landscape mode on full screen. It narrates a story by

playing 3D animated clips. Besides, children can interact with *Khel Tale* application by making decisions for the main character they choose. It happens when application asks them about choices of characters by showing them split screen with two choices.



**Fig. 1.** Child listening to mother's advice in *Khel Tale*

A story in this application is divided into episodes; and each episode is composed of 3D animated videos. The content of each episode contains a small lesson for children. In this case, an episode begins with playing a fixed 3D animated video clip which later shows two further choices. Thus, for that particular episode to conclude either a good choice or a bad choice. When a child makes a decision by selecting the desired action for the main character on split screen with choices, application plays the relevant 3D animated clip to continue with the story. In this way, children are able to see the consequences of their actions in the story. Each episode covers one topic and its narrative or storyline is not dependent on the other episodes [3]. Every episode in the end gives two choices to children to decide how it should end as illustrated in Figure 2.
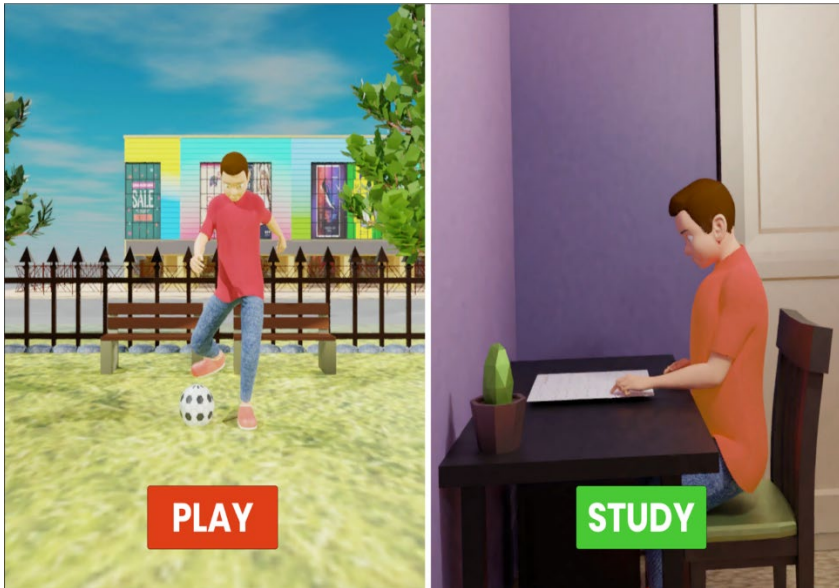
**Fig. 2.** *Khel Tale* asking children to make a choice for character

Application uses 3D animated videos that are rendered in child friendly style of visual arts. All 3D objects such as characters and models are constructed by using geometric modelling with the help of polygons [4]. It delivers a smooth animation and camera work that is similar to modern day child friendly cartoons. Furthermore, characters use rig for the animation and all the 3D objects use the key-frame animation. Thus, voice dubbing for games characters is done in Urdu language. Story of episodes in *Khel Tale* are written carefully so that children do not get bored. These stories are representing pure culture of Pakistani society.

*Khel Tale* is teaching children the main lessons regarding how to obey their elders. In modern times children are more into gadgets and new technologies because these things inspire them, attract them, and they love to play with them [5]. *Khel Tale* provides them friendly 3D animated graphics with valuable life lessons. The main purpose of 3D animation is to attract children towards the leading character so that they can relate themselves with that character. The decision-making option inside a story tells children what they can make decisions on the basis of their selection choice offered in the game. Sometimes children need to learn and understand that what can be the consequences of choosing wrong direction in their life story. However, they can get hurt in the process of reaction

shown by game in reality. So, it is a good way to show children that what can happen to them in reaction of choosing the wrong path with the help of a safe mobile application.

## B. *Animation*

Animation is just an illusion of an action which is generated or depicted by the series of rapid frames or images. It depicts movement and motion by flipping the still/non-movable images shown in the App, quickly. Animation can be classified into several types, some are listed and explained below.

Traditional animation is one of the oldest forms of animation, it is also referred as hand drawn animation sometimes. Moreover, it is used to draw the animation key frames with the help of a sequence. It shows images in series-based sequence which comes one after another, meanwhile presenting an illusion of a motion. Flip books are also considered in the series of pictures which shows a story in some sequence created by using traditional animation. This kind of sequence of pictures is still used by the designers. In this case, stop motion animation converts static objects to life with the help of photographic frames. It has different types including clay motion, puppets, cutouts, silhouette, action figures, and pixilation.

Computer animation is simply a process of generating animation with the help of a computer. It is the generation of moving images from a computer. It is the branch of CGI (Computer Generated Imagery) which is further classified into 2D and 3D animation. 2D animation allows the movement of different objects in a two-dimensional space, where objects could be anything including characters, vehicles, environments, backgrounds, and others. It's an illusion of smooth movement that is created in a 2D space when the drawings are arranged in the right sequence. It is a combination of hand drawing and digital artwork. It is also done usually with the help of sprite. A sprite is a 2D image that represents a single frame in an animation. A series or collection of sprites is called a sprite sheet. A sprite sheet is normally flipped at 24 frames per second at least to get smooth animation. In some cases, it is also flipped at 30° or even 60° angle.

3D animation allows the movement of different objects in a three-dimensional space, it involves the transformation of objects with respect to the movement, rotation, and scale. It is actually an art of bringing characters, vehicles, environments, and several objects closer to create more realistic

shape. 3D animation is done with the help of 3D modelled characters that uses geometric data. Animation is done with the help of key frames that uses linear interpolation principle in most common cases to move a 3D object from one point to another point in a scene with the help of interpolated frames. Furthermore, living creature models are rigged with the help of artificial bones and in this case, they are animated either by using forward kinematics or inverse kinematics. Besides, rigging add accuracy to the animation with the help of bones, joints, and end effectors. Another advance technique called motion capture is also used for 3D human animation, which maps the movement of an actual human being and transform it into a 3D human character with the help of a special suits by using sensors. It records the movement of the person with the help of sensors and apply it on the 3D character to accurately animate it.

## C. Background and History

It started over 25000 years ago, from cave paintings in Paleolithic which is an old stone age. Animal paintings placed in the caves depicted an image of motion, presenting that as if animals are actually moving. In 1500, a man named A.D Leonardo da Vinci drew a Vitruvian Man which presented different motions and angles. In 1603, Magic lantern became the first animation projector which displayed images by using pictures on glass sheet. In 1824, the invention of *Thaumatrope* from paper and string allowed children to see an illusion of combined images. In1941, *Phenakitoscope* came which created an illusion of motion with principles of vision. A cylinder-shaped device named Zoetrope generated illusion of motion with the succession of static still images in China during 1860's. In 1877, an improved Zoetrope version by the name of Praxinoscope came in France. As the time passed, the paper came into existence and available to everyone so after that people started making their own flip books. Flip book is a paper-based toy that depicts motion. It consists of connected layered sheets of paper with the linear sequence of images [6].

In the early 20th century, many animators started exploring facial expressions of people such as anger, humor, and other. 1900's is also considered as the era of animation. In 1914, first ever cartoon style animated movie by the name of Gertie the dinosaur featured an appealing dinosaur character. In 1919, Felix the Cat came with the first animated movie star. Walt Disney dominated the industry with its famous Mickey Mouse character, loved by both elders and children equally. Sound printing on the

film along with the cartoon animation became the main reason for its popularity. In 1930, Warner Brothers' famous character Bunny became the center of attention of every child and it is still loved by everyone. Snow-white came as the first-hand drawn feature film. Furthermore, its production process consumed a lot of time in order to make it a first full length animated film. After mid 1900's, American television dominated the animation specially from 1960 to 1980, as Crusader Rabbit appeared as first animated series on television. Later Flintstones appeared as the first sitcom animated series and then Jetsons. Yogi Bear also became famous in 1961 as it depicted the acts of a bear animal.

After 1980, CGI (Computer Generated Imagery) started to dominate the industry and brought revolutionary graphics. Pixar released Toy Story in 1995 as first fully computer-generated animated movie. After two decades it is still considered as a huge success. It changed the perspective of an animated movie [7]. Today, our modern world animations are fully backed up by computer assistance and animation. Thus, these animations are advancing day by day by using the new features and techniques for the process of ray tracing, light illumination, and rendering.

## II. Literature Review

Walt Disney came into existence in 1923, which is now known by the name of Walt Disney Company. Walt Disney started with short film Alice's Wonderland that showed interaction with the animated characters [8]. Later, they launched animated cartoon series by the name of Alice Comedies. After Alice Comedies, Walt Disney created a cartoon series featuring a popular character by the name of Oswald the Lucky Rabbit. Hence, Walt Disney produced the famous Mickey Mouse character in 1928 and featured it in its first sound film Steamboat Willie.

According to Gange in 1970, animation is a sequence of text and images. Traditional animation uses many popular 2D techniques [9]. Storyboarding technique defines the important and significant moments in story by using still images in order. It is a visual representation of series which runs in a smooth way. It divides a story into multiple scenes and each scene is then drawn on a separate sheet. Each scene is further described with notes that explained what is going on in this particular scene. It can also act as a visual guide. Key frame animation defines the movements from start to end of a specific transition. It contains information about the beginning and

completion of an animation [10]. Key drawings that define the shape and path of a particular animation are called key frames, and each single still drawing in between key frames acts as a frame in animation. So an animation becomes a combination of both key frames and frames. Another similar related technique is Inbetweening that outlines the important key frames for an object's animation to generate the intermediate frames between them. It improves key frames to give a better quality of motion. It is also known as twining that uses mathematical concepts of interpolation in order to smooth the motion and shape of objects in an amination. Other popular techniques are scan/paint) and multiplane background which further separates background from foreground [11].

3D computer animation uses the techniques from traditional 2D animation and extend those techniques so that they can be used for 3D animation, where 3D models are used instead of 2D illustrations. These fundamental principles from traditional 2D animation are included but not limited to squash and stretch, timing, anticipation, staging, follow through and overlapping action, straight ahead action and pose to pose action, slow in and out, arcs, exaggeration, secondary action, and appeal [12].

Models are represented in 3-dimensional space but are projected on 2-dimensional plane, resulting in a 3D representation of a 2D drawing on a screen. One of the most used and significant technique for 3D animation is key frame animation, in which position of 3D objects is interpolated between key frames [13]. A frame represents a particular state in an animation. For a key frame animation, the animator only defines the Key frames and resultant animation is generated using interpolation. Key frame animation allows an animator to define the position, rotation, and scale of 3D object at any particular frame, turning that frame into a key frame. Interpolation can be of any nature like linear, bilinear, cubic, spline, and others. Key frame animation is further used to create motion cycles, like cycle of walking or running.

3D character animation involves modelling a character in 3D and then rigging it with skeletons including bones. Rigging is the process of defining an internal skeleton of a 3D character and mapping it carefully with 3D character model parts. A single skeleton can be used on the basis different characters and being given the same character structure. Many animators in modern day are using automatic rigging that allows them to turn a static 3D model into an animated character easily [14]. In addition to it, after rigging

the most important part which is an animation, one of the most popular character of animation technique in kinematics. Kinematics refers to scientific discipline to consider movement without taking forces into account. Kinematics is further divided into forward kinematics and inverse kinematics [15]. Forward kinematics considers the movement and orientation of a single bone in a skeleton whereas inverse kinematics calculate the movement and orientation of all the bones in a single chain.

In modern world animation is becoming important in education sector, it is ranging from explaining the concept in a simple way that how to do animations for the complex scientific explanatory simulations. In addition to it, teachers are now adapting different ways to teach and communicate with their students. Verbal methods of teaching have dominated for a long time but now educators are taking assistance from the other methods as well. Mackenzie and Jansen [16] found out that while teaching process, the usage of graphics and multimedia is better than using the traditional methods. Instructions given through multimedia captured the attention of students more effectively. It showed that presenting the complex concepts in 3D is more effective as compared to the traditional 2D drawings. Animations combined with audio and video segments further helped in explaining the concepts. The current studies state [17] that animated graphical representations are more effective in communication and teaching than the printed materials. They can easily deliver different dynamic range of information as compared to static diagrams and images. Animation can become a good learning tool for students depending on the story of animation and design of its characters [18]. Additionally, giving expressions to the characters of the animation during any movement makes a positive impact. Psychology for colors used in animation also plays an important role in delivering the content to the students through an animation.

Whereas, children can build a strong relation with technology and can achieve a greater sense of empowerment. In future, the computing devices can be a part of every child's education and as it is expected that the children would be able to do more in future, what they could before [19]. Also, children can connect themselves with rich powerful technology and can take assistance in their schooling. In today's world, the computing power is increasing day by day. Thus, children can take advantage of modern-day technology to get quality education.

## III. Materials and Methods

In today's world, learning through different means is necessary. Moreover, children of the present age can easily adapt the various means of direct and indirect education with the help of animated videos. However, they can also entertain themselves at the same time from the animated video. For this purpose, the *Khel Tale* application focuses on teaching morals, ethics, and importance of advice from the elders towards children within 5 to 12 age group. Hence, effective learning always come through experience, so the primary idea is to give children a sense of simulated experience in the form of a decision-making story. The decision to adopt 3D instead of 2D graphics is because of the immense popularity of modern 3D graphics among children. 2D graphics relies on sprite sheets mostly. Whereas, 3D graphics are constructed with the help of mathematics and geometry.

### A. Story Writing

In writing a story for children, it is an important thing to keep in mind that it should be child friendly because any disturbing content can further lead to a bigger problem. Children are sensitive and even the little things can easily hurt them. Any violent or disturbing content can be really distressing for the children. Children are also impatient and they need quick results. For that reason, they want to see everything happening around very quickly. So, story has to be short and precise without any ambiguity or doubt, long advices, or exaggerated points without any specific reason. Thus, overemphasized points make them bore and they leave that thing immediately. It can be anything like an advice by parents or teacher, cartoons or any other thing.

In today's world, children observe that everyone is wasting their time in useless activities like playing games, watching TV, and others. As a result of this, they also start following the same path like others. For this case, wasting time is not a productive habit, even it makes them further lazy and ultimately it negatively affects their education. So, it is really essential for them to start using their time, wisely. Pilot episode is also focusing on wastage of time. In first episode, when the main character, 'child' comes home after school and his mother asks him to study for his exam first and not to waste his time. In that advice, she wants him to understand the value of time. Later, when the friend of the child comes home, and asks him to play. The child gets two options either to play or to study for exam. If the

child opts for the bad option and goes out to play, the next day he fails in exam because he did not study enough for his exam, last day and he ultimately loses his reward expected by his father. If he chooses good option and studies for the exam, the next day he passes the exam, and gets the reward as expected by his father. This story conveys important message regarding not to waste time for students, also to listen to the parent's advice ultimately shows that how much time is precious.

## B. Storyboarding

After story writing, storyboarding is an essential part to make an animation outstanding [20]. It consists of images and illustrations which are arranged in such a sequence that it conveys complete story in pictorial form on a paper. It describes each and every scene and shot. It depicts the flow of a story, and allows the author to see problems in more details. It creates a sequence that is closer to the actual animation. It is basically a sketch or outline of a story with the little description of dialogues. It is a simple method that helps in comprehending the story in a better way. For modelling purpose, after story writing and storyboarding, it becomes easier to identify the objects, environments, characters, and others. In general, it is a bird's eye view of whole animation for a story.

## C. Theme, Environment, and Characters Development



**Fig. 3.** *Khel Tale* characters left to right (Aliya, Adnan, Essa, Noman, and Shafiq)

The theme conveys or depicts the overall look and feel in terms of a content that is included but not limited to a story and its visual appearance including art style and colors, aural effects including dialogues, sound effects, and others. The overall animated themes in terms of content is exemplary, the dialogues are easier for children to understand, and they do not contain any kind offensive words. It is very eye catching and colorful in terms of visuals and art style. Mostly using gradient and flat shade colors with combination of textures as well, where necessary.

Every character has its own unique personality and characters which are created with the help of those personality traits. These traits are also reflected in animation and speaking style of a character and they are also visible on facial and body features of a character. There are five characters in *Khel Tale* application as illustrated in Figure 3.

Essa is the main character of *Khel Tale*, and he is the one who follows the decisions from the children between good and bad option. Essa is 9 years old and the only child of his parents. He is a school going student, and he is very humble and obedient. However, sometimes he ignores the advices of his parents which in return makes him suffer. He loves to play football. The other two characters are the parents of Essa. His father Adnan who is an engineer by profession, and he is 42 years old. His mother Aliya who is a housewife, and she is 40 years old. Both parents are very concerned about the well grooming of their only child, they constantly advise him regarding morals, ethics, and discipline. Another important character is Noman, who is school going neighborhood friend of Essa. Noman is a little weak in his studies, and he reads in the same class as Essa. Noman loves to play video games. The final character is teacher Shafiq, who teaches both Essa and Noman in the school. He is very punctual and disciplined teacher, and he likes to read books.

All the characters and stories are set in a city of Pakistan who resembles and are inspired of the capital city Islamabad. *Khel Tale* application revolves around Pakistani society, it depicts a friendly neighborhood with independent houses on the main street in front of a park. There is also a masjid nearby across the park, and a commercial market plaza. Masjid is an important part of Pakistani society as it is an Islamic country where majority of the population is Muslim. Likewise, the commercial market is also similar to the big commercial markets seen in the city of Islamabad. The home of Essa is right next to the home of Noman, and both homes are

situated right in front of a park. Park has a play area for children which consists of swings, slides and other things. It is a normal park which is mostly seen in Pakistan. It is also equipped with street lights and trees as well. Exterior of houses are simple yet modern, and equipped with main front gate with car ramp. Inside the house of main character, there are common room like bedroom, lounge, kitchen, dining, washroom, and lobby. All rooms are appropriately decorated and furnished.

### D. *Environment and Character Modelling*

3D modelling is a mathematical representation of three-dimensional objects in a computer. It is a technique which forms three dimensional objects with the help of computer software. 3D models are used to represent real world objects as visual arts inside computers. A 3D model is composed of vertices which are connected with one another to form edges. Edges are connected with one another in a closed loop to form a face, and the combination of these faces actually creates a mesh, which is a 3D model or 3D representation of a real-world object in computer [21].

A 3D model actually represents the basic building block in computer graphics design. Everything is first modeled with the help of basic primitive shapes like cube, sphere, cylinder which are composed from geometrical either from polygons or splines. Then these models are used to create things more complex shapes like buildings, structure, characters, vehicles, and everything that we see in an animated movie or in 3D rendered graphics.

Environment is modelled with basic primitive shapes mostly cubes. Cubes are extruded and tweaked to get the definitive shape of buildings, houses and other similar objects. Curved and circular objects are mostly driven from spheres and cylinders [22]. All material-based environment objects like structures, vehicles, furniture, plants, and others are mostly an advanced and complex combination of primitive shapes.

A character model is not different than an average 3D model, but it is the most complex combination of geometry points. A character is composed of as usual basic vertices, these vertices are joined together to form a full shape 3D character which is also known as a mesh. Mesh is formed with the help of faces and polygons. The basic structure of a character begins by modelling a face on a sketch. Sketch is created for front and side pose by hand, then the sketch is used as reference point to carve out the character from primitive shapes.
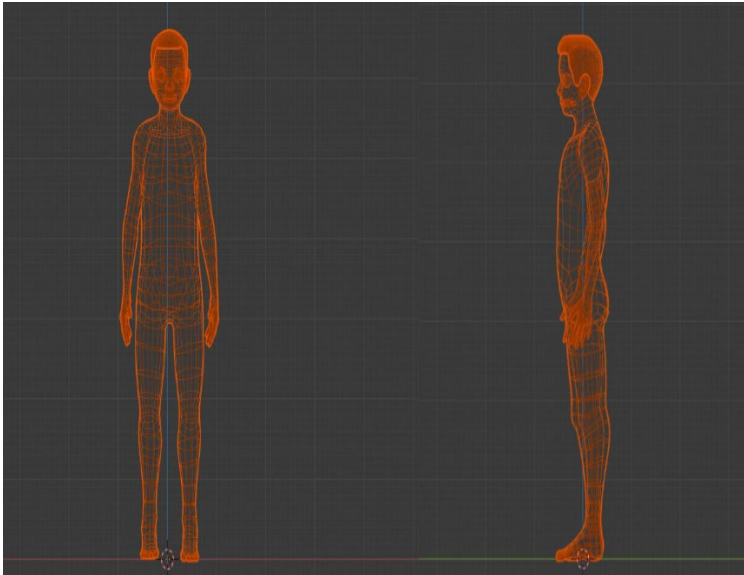
**Fig. 4.** Front and side pose of child 3D model showing vertices and edges in wireframe mode

Everything is carved out from basic primitive shapes, including the facial features. It starts with a basic cube over the reference sketch, and then the process begins by adding, mapping and moving vertices manually all over the sketch for the character. Each and every vertex is traced, and all of these tracings correspond to the shape that is sketched behind on the reference image. It starts from modelling the eyes then forehead, nose, lips, mouth, chin, the oval facial structure to complete the front view of a face. After completing the front model of a face, the side view mapping beings. 3D model has a different view from front and side. Each and every vertex is traced according to the reference image on side view as well. Both front and side view of models are created side by side because of the limitation of working on a 3D model in a 2D screen. Out of 3 axes in 3D, only 2 axes as a plane are visible accurately for orthogonal camera at same time. It has to be kept in mind that both sides of character contain same look, and mirror modifiers can be used to achieve that result. The process continues after the face, it then goes to neck and shoulder. The process involves filling the polygons as well to compose a full neck, shoulder, and ears. After that, the upper portion of torso which includes back and chest is created by extending the vertices, then lower part is completed with the help of reference images. Then comes the turn of arms, elbows, forearms, wrists, hands, and fingers.

Same process is repeated for legs, knees, ankles, feet, and toes. Finally, the head hairs are created to complete the full character. Figure 4 illustrates complete 3D model of main character's child in wireframe mode, which is showing all the vertices, edges and faces, along with their connections from front and side view.

The next part after modelling the biological features of a character is to model the apparels. The clothing is modelled in a similar way on the top of the character's body. Shirt, trouser, shoes, glasses, jewelry, and others are also modelled with the help of reference images as well. Sometimes they are extruded from the character's biological meshes, and sometimes they are carved out from scratch as well. Figure 5 illustrates complete 3D model of main character's child in clothing and shoes in solid mode, from front and side view.

**Fig. 5.** Front and side pose of child 3D model with clothing in solid mode

Visuals are extremely important and they are achieved with the help of materials in modern 3D computer graphics. A material can be considered as a layer that can be wrapped on the top of a 3D model to enhance its visual appearance. A material is responsible for the final color and texture of a 3D model [23]. It further aids in creating the desired visual effects with interaction of light. *Khel Tale* application used combination of diffuse and specular materials properties; diffuse materials are mainly used for rough

surfaces whereas the specular materials are used for shiny surfaces. The application did not used any transparent materials, however in few areas it used the mirror like reflection to reflect colors and light in the surrounding. The materials are simply using shaded gradient colors throughout the animation to give it a modern and more sophisticated look. The gradients used in application are mainly the combination of two colors. Character apparels are using fabric textures. The decorative items in the house and school like paintings or furniture are using textures. Outside the house and school, grass is using texture.

### E. Rigging and Animation

Animation of basic primitive 3D object is simply achieved with the help of key-frame animation, where an object's position, rotation, and scale are interpolated between two points, also called key-frames. The properties of an object like its position, rotation, scale, and others, at a starting point are recorded at a particular frame in timeline, which turns a frame into a key-frame. Then the object is moved, rotated, and scaled as desired and its properties at an ending point are recorded again on another different frame, which turns that particular frame into a key-frame as well. Now all the intermediate frames between those two marked key-frames are mathematically interpolated with the properties to create a smooth animation between those properties from start point to end point, and transform the object from its starting point state to its ending point state.

However, character contains a lot of vertices, and it is not easily possible for an animator to use simple key-frame animation. So, a character is rigged with bones and joints, similar to the bones and joints human body. These bones and joints are mapped to the corresponding vertices of character, the movement of bones inside a rig also moves the mapped vertices. Hence, it creates a realistic human like animation. Movement of each bone is also controlled with the help of same key-frame animation. Figure 6, illustrates complete rigged 3D model of main character's child mapped with its vertices, from front and side view.
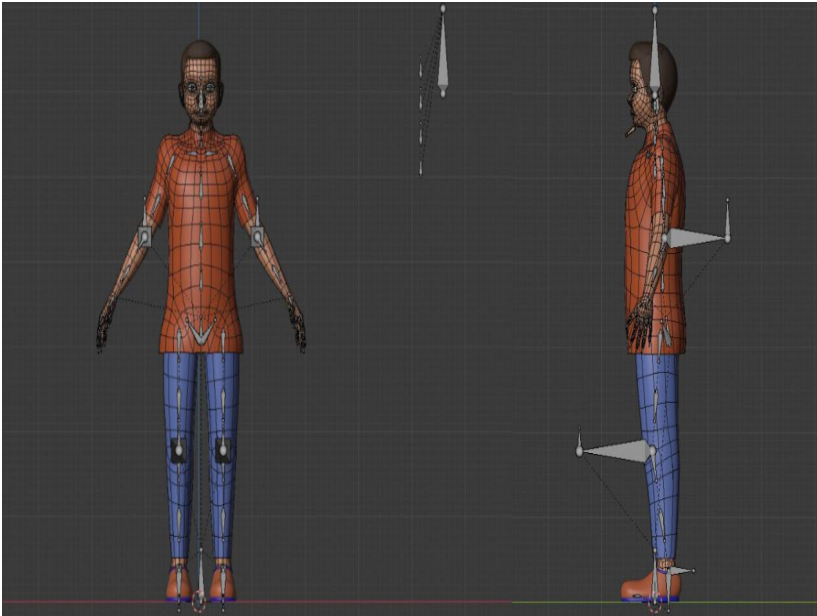
**Fig. 6.** Front and side pose of rigged child 3D model in solid mode

A rigged character is animated either by using forward kinematics or inverse kinematics. In forward kinematics, the entire hierarchy is rotated manually one by one [24]. For example, in order to rotate an arm using forward kinematics, all the hierarchy bones like shoulder, elbow, wrist and hand should be adjusted manually. In inverse kinematics only end effector is moved. For example, in order to rotate an arm using inverse kinematics, only wrist or hand would be manually adjusted and it adjusts all the other bones itself. *Khel Tale* application primarily uses inverse kinematics for most of its animation, only on few occasions to achieve extra accuracy which uses forward kinematics as well.

## F. *Lightning and Rendering*

Lightning is most crucial element to get the good visuals on screen [25]. Light is responsible not only for illuminating the objects but also for adding a factor of realism to it. It can be a point light, spot light, area light, or a directional light. It can have intensity and direction as well. Light can be direct or indirect. A direct light is the light that after hitting a surface only one time is converged to the camera sensor. Indirect light is more accurate to add realism factor as it calculates the multiple bounces of light reflection in a scene before hitting the camera sensor.

**Fig. 7.** High quality rendering on left and normal quality rendering on right

Rendering is the process of generating the final visual output after calculating the light and material properties on 3D models. *Khel Tale* application uses a combination of both direct and indirect light in rendering the final output. It uses global illumination to light up the whole scene which adds more realistic reflections along with soft and hard shadows. It is also using ambient light in the background as well. All the lights in application are baked with multiple reflection settings. Animation is using area lights and point lights inside the house and school. It is using directional lights to imitate the effect of sun in the environment outside the house. An environmental HDRI texture is simulating the sky separately for day time and evening time. It uses high quality rendering settings. After rendering, in order to get rid of minor noise elements around the corner of objects in images, a denoiser is used to balance the light and remove the noise. Figure 7 illustrates the high-quality rendering with around 100 indirect bounces of light using global illumination on left side, and a normal quality rendering with regular quality light settings on right side.

## G. *Video Editing and Audio Dubbing*

After the rendering of all the animated scenes, they are joined together by using a video editing software. Multiple cameras have recorded every scene, pointing towards different locations and angles by using different

zoom settings. Videos are stitched together after viewing and selecting the appropriate cameras to cover the respected scene.

Audio is recorded of every dialogue in Urdu for each character in *Khel Tale* for all the scenes and shots. Then audio clips are overlapped in a video editor timeline over the related videos, and synchronized altogether. Sound effects and music is also added to enhance the overall experience of animated story. Every scene and shot is post processed and exported in standard video encoding, so that it can be played in *Khel Tale* mobile application.

## H.  Application Development

Finally, the *Khel Tale* mobile application is developed for children that allowed them to play and watch the 3D animated story. The application uses the final rendered high quality Urdu dubbed videos. It allows the children to make the decision for their main character. After the decision, the application plays the appropriate 3D animated video associated with the selected ending. Application also records the activity of children regarding their decision making, and it sends the data over the internet for research purpose after the permission and consent of parents.

## IV.  Results and Discussion

The current study investigated the effects of indirect advices given by the 3D animated characters to children in choice-based story mobile application *Khel Tale*. Further, the present study explored that if the choices made in second and third attempt by the same child on same episode is different or not, depending on seeing the consequence of the previous choices. This study also aimed to find out the usefulness and appropriateness of the methodology used for teaching children indirectly with the help of *Khel Tale* application [26].

## A.  Research Design

A quantitative research design is used in the current study to effectively measure the performance of the *Khel Tale* application in the statistical terms. Also, in quantitative methodology the information can be analyzed numerically. The present study focuses on one main question which is asked three times to observe that if the child is actually picking up the advice or not. The current study questioned the choice of a child three times repeatedly for same episode. What option the child picked the first time?

What option the child picked the second time for the same episode? And what option the child picked the third time for the same episode?

The reason of exploring the same question of picking the option for third time is because many children can choose the other option second time just to see the alternate ending of an episode, but for third time they can easily make an appropriate decision about the ending they liked the most among good and bad ending.

## B. Participants

The current study included the children of age group (6 to 10) by taking the permission of their parents. It was especially done in order to collect the data about their usage of *Khel Tale* application about the choices they made while playing or listening to the story. In most cases, they operated under the supervision of their parents or their elders but the parents did not interfere in their decision making. Total 20 school going children participated in this study by including both male and female children from Punjab, Sindh, and Islamabad (Federal).

## C. Data Collection

Children used and played the story on their parents' mobile phones multiple times. The *Khel Tale* application automatically collected the data about the choices of a child who played the game under the name of that child. At the end parents used the Send Report button inside the *Khel Tale* application to send the data for processing and analyzation.

## D. Findings

In the first attempt by children to pick from good and bad option, 11 out of 20 children picked the good option. In the second attempt by children to pick from good and bad option for the same episode, 13 out of 20 children picked the good option. Out of these 13 children, 8 children actually came from bad option while the 5 children did not change their decision of good option from their second attempt, and 6 children went to try out the bad option. In total for second attempt 14 children changed their decision. In the third attempt by children to pick from good and bad option for the same episode, 19 out of 20 children picked the good option. The 13 children who picked good option in second attempt stood by their decision, the 6 children who went to try out alternate bad option also came back and picked up the

good option again. All children statistics regarding the selection of option for first, second and third attempt are listed in Table 1.

**Table I**
Number of Children Picking Good and Bad Options in Three Attempts

| Attempt Number | Picked Good | Picked Bad | Changed from Good to Bad | Changed from Bad to Good |
|---|---|---|---|---|
| First | 11 | 9 | - | - |
| Second | 13 | 7 | 6 | 8 |
| Third | 19 | 1 | 0 | 6 |

The current study clearly showed that after three iterations, 95% children ended up with the good option in the end. These 19 out of 20 children consisted of those children who either picked the good option, stayed with it or who tried the both options and, in the end, decided to go with the good option. The child who decided to pick the bad option even after three iterations is the only child who never seen the reward of the good option. Total 5 children stayed with the good option in all three attempts and only 1 child stayed with the bad option in all three attempts. Also 14 children decided to stay with good option after seeing the consequences of the bad option. A more visual illustration of results in the form of graph is shown in Figure 8.
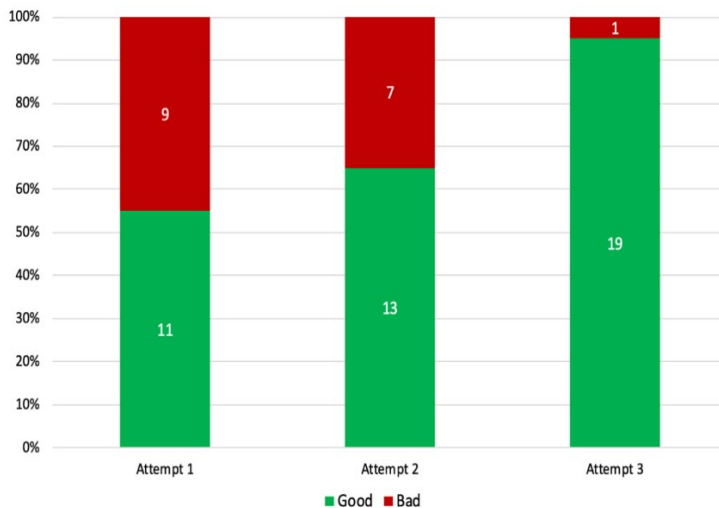


**Fig. 8.** Number of children picking good and bad options in three attempts

*Khel Tale* mobile application clearly showed the effective results. Some children picked the good option from start and never changed it even after several attempts because they actually listened to the advice and followed it. Some children who saw the both good and bad options result decided to stay with the good option. Children wanted their main character to get the reward as an outcome of a good action instead of a punishment as a consequence of a bad action. This is due to their connection with the main character of a story. They decided to pick the option that is appropriate for the main character in the story. Thus, they actually followed the advice given to the main character from their parents.

## V. Conclusion

The current study claims that children nowadays seldom pay heed to the advices of their elders. They often considered those advises as a boring lecture and ignores them. This study proposes an approach to teach the children by the means of a decision-based 3D animated story application, where a child can make decisions on behalf of the main character in the presented story by the story app. In this case, children can instantly see the consequences of their actions, and they get a chance to learn from it without getting hurt. The *Khel Tale* application for this purpose use child friendly 3D animations in which the main character is also a child. In this way, children can easily relate themselves with the main character. The game application features Urdu dubbed animations with all the modern computer animation techniques like advanced 3D modelling, texturing, rigging, and the advanced light rendering techniques.

The current study concluded that the children actually learned a valuable lesson from the *Khel Tale* mobile application. The children interacted with *Khel Tale* application by making decisions for the main character. This game is divided into episodes in which each episode uses animated videos. The story of each episode covers a specific moral lesson for children. They play an episode multiple times to learn the good or bad advices through both good and bad options. Also, they observe the main character receiving rewards when they listen to the advice of their parents in a good ending of the story. They also observe the punishments their characters face when they ignore the advices of their parents in a bad ending. Most of the children ultimately decided to stick with the good ending option, no matter how much the other bad ending option tempted them. Thus, children observed the advices given to the main characters from their parents. That's how, they

connected themselves with the main character and decided to pick an action that suited best for the main character in the story. In addition, apart from ethical education, this application can be advanced further to teach the children about other disciplines such as natural and social sciences etc.

## References

[1] S. Cavalier and S. Chomet, *The world history of animation*. University of California Press, 2011.

[2] G. Bendazzi, Animation: A world history: Foundations-the golden age, vol. 1. CRC Press, 2015.

[3] G. Bendazzi, Animation: A world history: The birth of a style-the three markets, vol. 2. CRC Press. 2015.

[4] G. Bendazzi, Animation: A world history. Contemporary times, Vol. 3. CRC Press, 2015.

[5] O. Johnston and F. Thomas, The Illusion of life: Disney animation. Disney editions. 1995.

[6] R. M. Gagne, Learning theory, educational media, and individualized Instruction. ERIC, 1970.

[7] F. Gracer and M. W. Blagen, "A system for storyboard animation" in *Proc. 9th Ann UAIDE Meeting*, 1970, pp. 210-255.

[8] N. Burtnyk and M. Wein, "Interactive skeleton techniques for enhancing motion dynamics in key frame animation," *Commun. ACM*, vol. 19, no. 10, pp. 564-569, 1976, doi: https://doi.org/10.1145/360349.360357

[9] D. H. Kochanek and R. H. Bartels, "Interpolating splines for keyframe animation," in *Nation. Comput. Graph. Assoc. Canada Conf. Graph. Interf.*, 1984, pp. 41-42.

[10] M. Levoy, "A color animation system: Based on the multiplane technique," *SIGGRAPH Comput. Graph.*, vol. 11, no. 2, pp. 65-71, 1977, doi: https://doi.org/10.1145/965141.563871

[11] J. Lasseter, "Principles of traditional animation applied to 3D computer animation" in *Proc. 14th Ann. Conf. Comput. Graph. Interac. Techniq.*, 1987, pp. 35-44.

[12] D. Sturman, "Interactive key frame animation of 3-D articulated models," in *Graph Interf.*, vol. 86, 1984.

[13] I. Baran and J. Popović, "Automatic rigging and animation of 3-d characters," *ACM Trans. Graph.*, vol. 26, no. 3, p. 72-es, 2007, doi: https://doi.org/10.1145/1276377.1276467

[14] R. Filkorn and M. Kocan, "Simulation of human body Kinematics," *Depart. Comput. Sci. Eng. Slovak Univ. Technol.*, 2000.

[15] D. S. Mackenzie and D. G. Jansen, "Impact of multimedia computer-based instruction on student comprehension of drafting principles," *J. Indust. Teach. Educ.*, vol. 35, no. 4, 1998.

[16] N. H. Hari Narayanan and M. Hegarty, "Multimedia design for communication of dynamic information," *Int. J. Hum. Comput. Stud.*, vol. 57, no. 4, pp. 279-315, 2002, doi: https://doi.org/10.1006/ijhc.2002.1019

[17] P. K. Bopche, "Animation: A learning tool," Ph.D. dessertation, Dep. Indust. Des. Nation. Insti. Technol. Rourkela, India, 2015.

[18] R. M. C. Williams, "Image, text, and story: Comics and graphic novels in the classroom," *Art Educ.*, vol. 61, no. 6, pp. 13-19, 2008, doi: https://doi.org/10.1080/00043125.2008.11652072

[19] M. Z. Sinor, "Comparison between conventional health promotion and use of cartoon animation in delivering oral health education," *Int. J. Humanit. Soc. Sci.*, vol. 1, no. 3, pp. 169-174, 2011.

[20] H. Cho, The use of cartoons as a teaching tool in middle school mathematics. ERIC, 2012.

[21] I. K. Macgillivray, "Using cartoons to teach students about stereotypes and discrimination: One teacher's lessons from South Park," *J. Curriculum Pedagog.*, vol. 2, no. 1, pp. 133-147, 2005, doi: https://doi.org/10.1080/15505170.2005.10411533

[22] S. Schiau et al., "How do cartoons teach children? A comparative analysis on preschoolers and schoolchildren," *J. Media Res.*, vol. 6, no. 3, pp. 37-49, 2013.

[23] N. Abd Rahim, H. A. Halim, and R. Mamat, "Learning via television cartoon," *Asian Soc. Sci.*, vol. 10, no. 15, pp. 8-15, 2014, doi: http://dx.doi.org/10.5539/ass.v10n15p8

[24] R. N. H. de Leeuw and C. A. van der Laan, "Helping behavior in Disney animated movies and children's helping behavior in the Netherlands," *J. Child. Media*, vol. 12, no. 2, pp. 159-174, 2018, doi: https://doi.org/10.1080/17482798.2017.1409245

[25] S. Papert, *Children, computers and powerful ideas*. Basic Book, 1990.

[26] L. J. Couse and D. W. Chen, "A tablet computer for young children? Exploring its viability for early childhood education," *J. Res. Technol. Educ.*, vol. 43, no. 1, pp. 75-96, 2010, doi: https://doi.org/10.1080/15391523.2010.10782562