



# Designing for Children

- With focus on 'Play + Learn'

## Story Based Schema Building Approach in Science Learning

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### Abstract

Stories have been used as a means of knowledge dissemination since prehistoric times. In recent years there has been a return to stories as an educational tool. Currently there are two approaches for communicating educational content as a story. One is reporting of a historical, biographical event related to discovery of a phenomenon, other is re-enactment of a knowledge discovery event in the form of a fictionalized story. These approaches have advantages and disadvantages. A biographical story is authentic from educational point of view, but current students may not be able to relate to it since it lacks the qualities of a fictional story. On the other hand, fictional stories may be engaging, but they may lack the authenticity of the educational content. This paper proposes a story building tool that integrates the advantages of both the approaches and enables teachers and content developers to deliver authentic educational content that is also engaging for the learner.

The tool has been derived by integrating three domains; narrative theory, philosophy of knowledge and the concept of accommodation and assimilation of new schema into existing one from Constructivist theory of learning. The story building tool enables teachers and content developers to create schemas for the students by building stories that revolve around a particular subject matter. The tool can also be learnt by students and they can participate in building an educational story.

*Keywords: Story, Schema, Knowledge, Learning, Distinction*

## Introduction

Storytelling is one of the oldest means of communication prevalent in the human civilization without which humans could not have expressed their knowledge or thought (Mello, 2001). It is a way by which humans transmit their individual experience with others forming a kind of negotiated transaction (Mello, 2001). The study of narratives has gone beyond the discipline of literature in various other domains like Science, Social science, Management and Motivation. It appears that telling of stories may have some kind of primordial connections with human thought itself. According to (Bell, 1991):

“The nature of narrative has for several decades now aroused speculation extending beyond the literary realm into a variety of disciplines concerned with the fundamental construction of meaning. The shaping of experience by Narrative, indeed the very impulse to tell stories, may suggest primordial, but subliminal, processes underlying even the apparently independent planes of reason or evidence.”

In some of the recent studies on science education, emphasis has been given to the design process of any educational stories by Yannis Hadzigeorgiou, Isabelle, Arthur Stinner, Harvey Williams and Stephan Klassen. In India there are also some private organizations that have converted the central government based NCERT text books into comic books. In these varying approaches, we see the use of stories in two distinct ways. One is a reenactment of a biographical event in the life of a scientist (Hadzigeorgiou, 2006). Such stories are also sometimes presented as scientific case studies. The other approach is fictionalized stories written to explain scientific concepts. Two of such titles are Young Scientists and I ken books. These books are not part of the mainstream curriculum and their validity is questionable according to academic standards. The examples of stories that have been included in the science curriculum are of biographical stories. Biographical stories are considered valid by academic standards as they do not distort the subject matter. They are also objective and do not contain subjective bias of the author which fictional stories may contain. However in some of the recent researches, there has been an emphasis on fictionalizing the biographical content to suit the context of the current times (Klassen, 2008). The current methods of combining biographical factual information with fictional events to match modern contexts, do not take into consideration the existing schema or prior knowledge of the learners from various socio-cultural background. This is also the problem experienced in centralized content development where a story targeted to an urban setting, may not be relatable by a student in a village setting. This point of catering to the needs of variety of learners is of most significance in the Indian educational scenario where there are vast differences in the socio - economic and cultural

background of students. This was emphasized by Dr. Jyotsana Tiwari, a reader at Department of Education in Arts & Aesthetics at NCERT. In this article we present a story designing approach based upon the idea of schema building from the theory of constructivism and show how these issues can be resolved in this approach.

### **Overview of existing Story designing approaches for science learning**

The approach of story designing by Yanni Hadzigeorgiou deals with historical account of a knowledge discovery event. The biographies revolve around controversial debates among scientist over the same phenomenon. He gives the example of Galvani, Volta and Michael Faraday for building story of current electricity (Hadzigeorgiou, 2006). It may be noticed that Yanni's story building guidelines for physics education are centered around the idea of humanizing the experience of learning science which comes from the various efforts currently being made to connect science education to the idea of responsible citizenship, where it is recognized that science learning is not just about accumulating facts, but it is also about imbibing values of objectivity, curiosity, Pursuit of truth, intellectual honesty, humility and commitment to human welfare (Hadzigeorgiou, 2006). It is for these reasons storytelling is the most appropriate way by which such goals can be achieved.

Second approach to story making is presented by Aaron D. Isabelle where again biographical accounts of a knowledge discovery event are narrated. This approach is part of the overall instructional strategy called the Launch, Explore, Summarize (LES) model of learning. In this children are given actual physical object to activate prior knowledge of the subject matter, then they are told a story regarding the objects given to play with and in the third phase, connections are built between the story and the activity they did in the first phase. The story presented by Isabelle is partly fictionalized, after telling of the story the factual and the fictional aspects are discussed in the class (Isabelle, 2007).

The third approach presented by Arthur Stinner and Harvey Williams combines the alternative conceptual framework theory and Piaget's constructivist theory of learning into a learning strategy that uses storytelling as the prime pedagogic tool. The main concept is built around what is known as a large context problem (LCP). For example, if Atom model is to be taught as an LCP, then instead of teaching Bohr model of atom, the various ideas concerning discovery of atom starting from Ionians to Dalton are knitted in to a story that shows how the idea of atom has evolved over the ages (Stinner and Williams, 1993).

These approaches to science learning use historical context as the central binding node and they are backed by published research data to validate them. However, there are also some publishers, who publish books that use fictional storytelling to explain scientific concepts. Two such titles are Young Scientists and I ken Books. While the young scientist shows characters in a modern context trying to solve a problem and discovering some scientific principle in the process, I ken books on the other hand have a common mascot, JC, who is the central character in all the stories who finds himself in one problem or other and is assisted by other characters in solving the problem. The advantage of such books is that they present a context which is closer to the modern learner. The context of playing video games, going to party, going to a shop or a national park, a modern learner can relate to. However, the authenticity of the educational content can be challenged in these stories. There is no research showing that the educational content will not build a wrong schema of the physical world in the mind of the reader however engaging the stories and the visuals may be. Caution is also recommended by National Curriculum Framework in proposing materials that use too many “cartoons” and make science learning a trivial affair (NCERT, 2006).

There is a third approach that combines the historical, factual approach with fictionalized story approach and it is emphasized by researcher Stephan Klassen. This approach, adds fictional element in a historically correct science story to connect the problem context for modern students.

Klassen has specifically put emphasis on writing a “good science story” by integrating story design principles with design of science story. The story that Klassen chose to analyze is used with a science laboratory experiment. Klassen points out that the classroom exercise does not have a context, and context is what triggers the interest of students by giving them answer to the question “Why they should be doing a particular exercise”. Story provides such a context for the exercise. It connects the knowledge with real life situations in which such knowledge comes in handy in solving a real life problem. However, the approach shown by Klassen is only meant for literary criticism of the story (Klassen, 2008). We contend that in order to develop any kind of guidelines for designing an educational story, we need to look into some fundamental views on the nature of philosophy of knowledge, learning and narratives.

### **Theoretical foundation of the story building model**

The main objective of the story building approach that we are proposing is to inculcate in the learner, the ability to recognize distinctions, how one thing or entity or phenomenon

is distinct from another. This goal is chosen from foundations of philosophy and logic. Here we would like to quote C.S.Pierce to make our point clear:

“Whoever has looked into a modern treatise on logic of the common sort, will doubtless remember the two distinctions between clear and obscure conceptions, and between distinct and confused conceptions. They have lain in the books now for nigh two centuries, unimproved and unmodified, and are generally reckoned by logicians as among the gems of their doctrine...

...I take it, however, that when the logicians speak of "clearness," they mean nothing more than such a familiarity with an idea, since they regard the quality as but a small merit, which needs to be supplemented by another, which they call distinctness.” (Pierce, 1878)

We believe that the idea of holding a distinction clearly as an entity is central to learning. Whenever we distinctly recognize a thing A, it itself contains all the other entities that are not A. This forms a binary pair of that and not that. This kind of thought process of binary pairs runs like a chain binding all of human thought across ages and civilizations. It has been recognized in Structuralism as the central node of human thought (Hawkes, T.1978). The foundational philosophy that we are following in our story building approach is that *binary pairing enables clear comprehension of distinctions*. The pairing of distinctions binds a construct into a system of which it is a part. This idea is affirmed by Piaget and is quoted by George E. Forman and David Kushner:

“When we read Piaget carefully, we begin to realize that there is no physical fact that can stand independent of some system of relations that gives it meaning. The color red, surely thought by many to be a raw and uninterrupted sensation, is not understood as red until it is implicitly compared by the observer to colors that are not red. Our eyes may be stimulated by the red band of light, but that wavelength does not become known to us as red until we think (albeit automatically) about it, compare red to not red, or, in more general terms, compare A to not -A. At some other time we can look at the same stimulus A and compare it to something else-for example to a darker object. There are infinite numbers of not-A comparisons that are possible, and it is the observer who makes the choice, not the environment.”(Forman, Kushner, 1993)

The idea of binary pairing goes back to the Greek's foundations of philosophy. It was found in the works of Ionians and Pythagoras. Socrates, Plato and Aristotle too affirmed it in their philosophies (Harris, 1969). It was also disguised in Kant's theory of a priori and posteriori knowledge. Bertrand Russell was using the same principle when he explained knowledge of Things and knowledge of Universals acquired either by Acquaintance or by Description (Russell, 1980). Levi Strauss has used the concept of binary pairing to explain

the structure of ancient myths (Levi, 1983). Story making inherently contain the concept of binary pairing that exists in the form of Protagonist and Antagonist. It is on these foundations that we built our story making model.

### Story making Model for explaining science concepts

Our model works by recalling prior information in the form of a schema and adding new information to it. Schemas can be defined in very complex to very simple ways. The simplest of way a schema can be defined is that it is a set of expectations (Mandler, 1984). The story model that we propose has three basic elements in a triangular relation

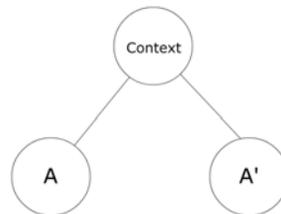


Figure:1

A is any entity that has its existential relevance in a certain context. A' is another entity but it is not relevant or lesser relevant in the same context. This model actually is a "schema" for understanding the world around us. The entities A and A' can be replaced by anything and we can form a desired story structure to explain the existence of something. X and Y are challenging components of the story and C is the context in which they are operating (see figure2). If we apply this schema to the evolution of a product, we will see that for a given context, there is more than one entity that fit in to fulfill the context. For example for filling the function of light, we have the Greek torch, a fuel lamp, an arc lamp, an incandescent lamp and a fluorescent lamp in succession. And the succession has happened in paired comparison of which is a better producer of light. Greek Torch or Fuel Lamp, Fuel Lamp or Arc Lamp, Arc lamp or Incandescent Lamp, Incandescent Lamp or Fluorescent Lamp. In the scenario of product, the same schema will look like this:

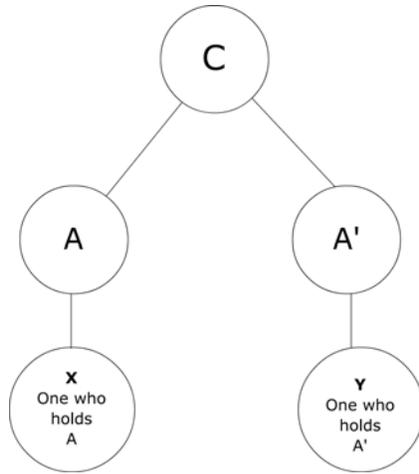


Figure2:

The model can be further represented in the context of competing manufacturers as shown in figure 3.

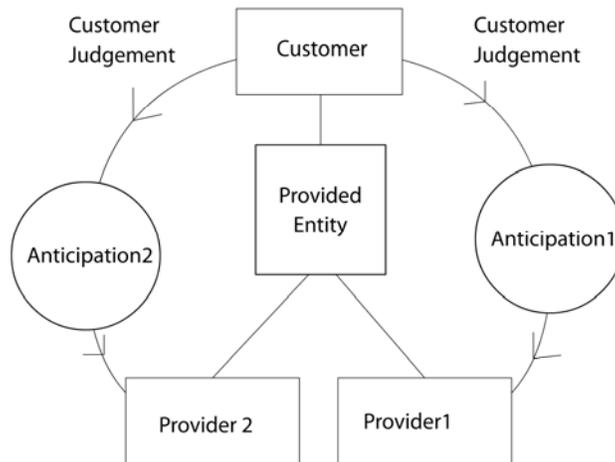


Figure 3.

The model now has five components:

- 1) Provider
- 2) Customer
- 3) Provided entity
- 4) Anticipation
- 5) Customer judgment

**Provider:** It can be a single person, group of people, a community or an organization who gives something to the customer. For example, a laborer giving his services to a civil engineer, a doctor giving services to his patient, a politician giving services to the citizens, a researcher proposes his ideas to the scientific community.

**Customer:** Someone who receives a service. For example the civil engineer, a patient, a citizen, a scientific community in above cases.

**Provider 1 and 2:** Providers are the mutually challenging forces in the plot. Each provider, in order to make the customer happy, improves the quality of what he is providing or does whatever actions needed in order to win the attention of the customer. Providers may indulge in unhealthy challenge. This is also an important part of the plot development. The winning provider is the one who instead of indulging in unhealthy challenge and trying to lure the customer is honest to his trade and works only for the betterment of the entity he wants to provide the customer

**Anticipation:** This is the arguments and internal thought processes that articulate the gap between what the customer needs and what the provider has at the moment. Anticipation is where the gap is reduced. Anticipation could be a wise person, or a manager of a company, anybody who provides a reflective element on a failed attempt. This will start the anticipation process where the Provider will be compelled to think what went wrong in their effort. For example, arguments among politicians after loosing the election and planning the next strategy or the internal dialogue of a researcher after his theory are rejected by the scientific community. It is in the act of rejection that one is compelled to seek new answers. The better idea or the party with a better idea prevails.

**Customer Judgment:** This is the choice that the client makes in the end about which provider it wants to choose as most appropriate in a given situation. This could be an outside person or one's internal dialogue to clarify whether the concept at hand is workable or useful for a given situation.

**Provided entity:** This is the thing that provider is giving to the customer. It can be a theory that a scientist wants to propose to the scientific community. It could be a policy that a minister wants to introduce for the public. It could be a product that a company wants to sell to the buyer. This story model does not have a concept of a protagonist or antagonist. The forces challenging each other are old knowledge against new proposition.

This way schema of story plots can be built related to infinite number of product items and knowledge associated with the items can be imparted. Here we present a sample story built using the story plot building model

### **Case Story: The story of a light bulb manufacturer**

In this story one can explain the concept of a filament, elements, good and bad conductors of electricity, current, heat and light emitting charged ions by creating two competing bulb manufacturers as the main protagonists of the story. Both manufacturers want to give a better choice to the user, the customer whose concern is reducing her electricity bill. This way we have a chain of customers who become providers for the next

customer in the chain. And in order to compete and stay at an upper hand, they find specific limitations of the existing product or element and find a new and better product, (a low electricity consuming bulb for example). By knowing what is different in the new entity, contrasting from the old one, knowledge at various level of the given subject gets transferred. See figure4:

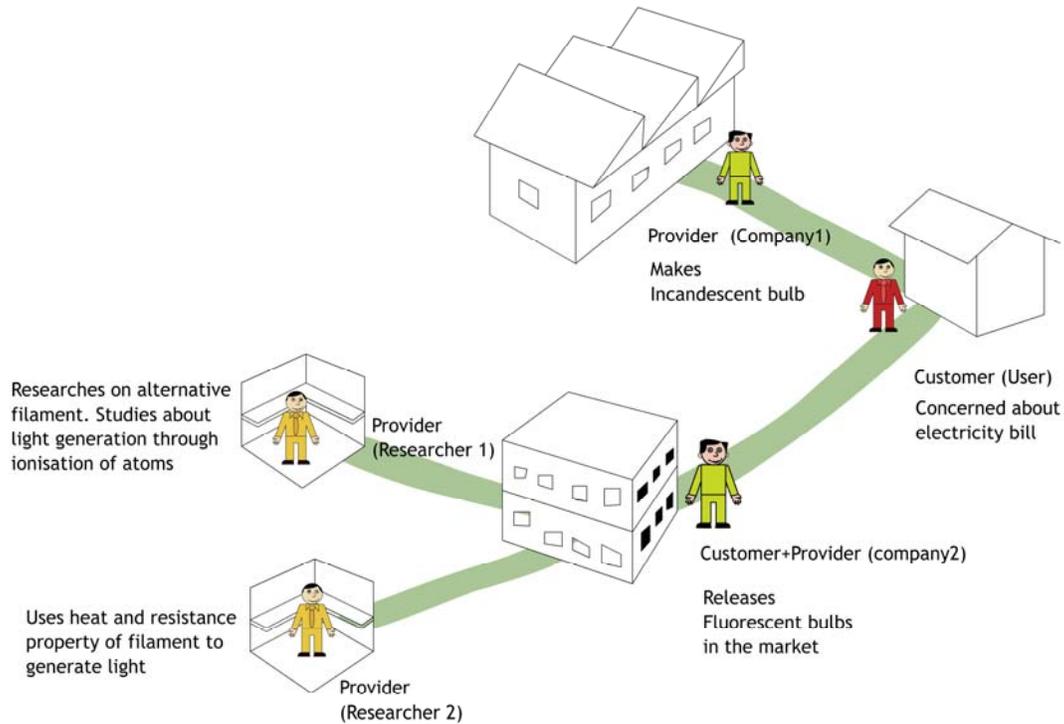


Figure 4:

## Conclusion

This paper is part of an ongoing research which shows how stories can be used to help in visualizing distinctions regarding scientific concepts for the learner. This model enables the learner to co-create the story along with the instructor. Further experimentations are currently going on to test how effectively instructors and learners can use this model in building their own knowledge stories.

## Future work

We also propose that not only can this model be used in science, but other domains as social sciences, Management and Moral education. It can also be used at high school and college level, but independent researches need to be undertaken to validate this claim.

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