# Implementation of Non-Linearity and Interactivity in e-Learning

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## Abstract

In this paper, we will discuss three aspects. Initially, we will explain the methods we used for developing interactive content. Then we will detail the technology elements that we incorporated in our learning environment. Finally, we also described the simulations that we developed for providing high degree of experience to the students.

The architecture used in WWK is Model View Controller architecture. Java applets and Flash animations are extensively used for interactive simulations. All components for use, operations, maintenance and content development are accessible via web-enabled devices, using web (http) protocols for access.

## 1. Introduction

**"Wonder Whiz Kids"** creates an innovative, inquiry based, interactive learning environment to acquire knowledge, gain insights and think intuitively. WWK is for students of age 12 years and above, parents, teachers and all those who are interested in promotion of science and scientific thinking. The main features of this portal are **visualization, concept related content sequencing, interactive and collaborative learning, self-assessment, games and simulations.** The content would be informative, interesting and interactive to sustain and enhance the span of attention while helping the student to **understand the fundamental concepts of science and apply them gainfully to real world situations.**

## 2. Content creation

### 2.1 Concept related content sequencing----- Structuring

Content sequencing is the efficient ordering of content in such a way so as to facilitate the learning process. There are several general methods of sequencing content.

One well-known method is concept-related content, which is described by **Posner and Strike** [1]. The concept related scheme suggests sequencing based on the relationships between concepts.

A definition of "concept" based on **Bloom's model** for Mastery Learning [2] is as follows: "A concept is a semantically meaningful unit of instruction with a specific intent type and a matching instruction and evaluation type". A concept must have clear learning objectives. This will make sure that the concepts are of a reasonable breadth and depth.

The content sequencing is based on a concept-related strategy. The subject matter expert identifies the various concepts, which constitute the course content. WWK provides the course designer with an interface to structure the course content thereby building a map of the course. This course map provides a systematic method for presenting the content that is likely to match the learner's expectations.

The course designer is allowed to design the course in the form of topics, sub-topics, sub-subtopics. Topics are similar to what are known as Learning Objects in other tools (SCORM) and as such, each topic is stored internally as a separate object.

### 2.2 Visualization -----Flash Animations

Concepts that involve spatial movements of tiny particles or 3 dimensional layouts are best understood through visualization. Hybridisation, polymerisation, reaction types, working of heat engines, lenses, mirrors, are some of the concepts that are much easier to understand through visualization.

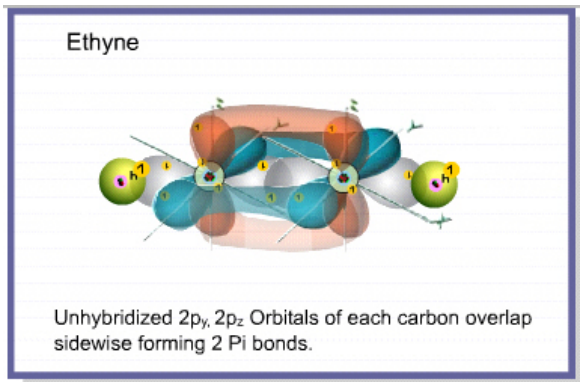


**Figure 1** sp Hybridisation In Carbon Atoms

The students can visualize how exactly the reaction is taking place step by step and also can analyse the factors affecting the type of reactions. They can also see how carbon undergoes different types of hybridisation, leading to millions of organic compounds.

WWK relies on using flash animations effectively to explain the concepts which are usually the most difficult for students to understand.

### 2.3 Managing the content

Learning content is broken down to modules. Modular learning objects could be re-used in different contexts and could more easily be updated than large integrated blocks of content. The course designer associates content with a topic, but stores the content separately. It may be modified independent of the rest of the object by the content developer.

## 3. Learning Environment

Obviously e-learning offers several tools that are otherwise non-implementable in other forms of education. The learning management system of WonderWhizKids works on the following interactive tools.

### 3.1 Collaboration tools ---- Chat

This term is often used to refer to the asynchronous and synchronous tools integrated with learning management systems to support collaborative learning. Asynchronous tools include threaded

discussion groups and e-mail, while synchronous tools include virtual classroom platforms, “whiteboarding”, online chat and application sharing.

Synchronous, or live e-Learning, means that communication occurs at the same time between individuals, and information is accessed instantly.

### 3.2 Self - assessment ----Quiz

One of the most important educational components is the assessment of the student’s acquired knowledge.

SA provides the means of evaluating the student’s acquired knowledge and valuable feedback regarding his performance (the grade, a bar graph, the correct answers etc).

SA is a highly dynamic component of the WonderWhizKids methodology, involving both synchronous and asynchronous communication between students and instructor. In order to build a model of SA, we analyzed the assessment process, different possible scenarios, relationships between different concepts and different assessment types.

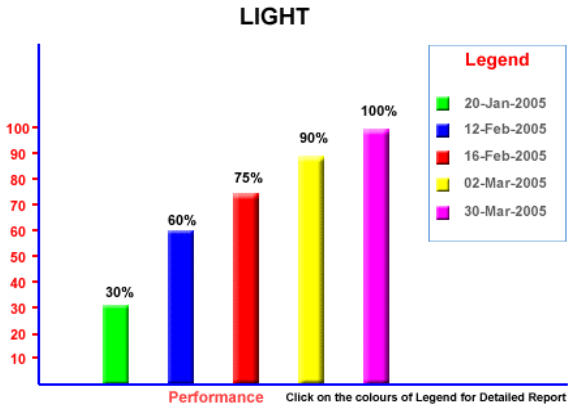


**Figure 2** Assessment Report - Bar Graph

### 3.3 Games

Game-based learning is proving the most engaging and effective means of acquiring new knowledge and stimulating new thinking. Learner tends to be more involved. Learner interacts with game and concentrates on learning the material. Learners think it's great, since they are learning and enjoying themselves at the same time – an unprecedented combination.

WWK provides games like cross word, memory game for each sub topic. Interactive presentation of material provided within a game-like framework.

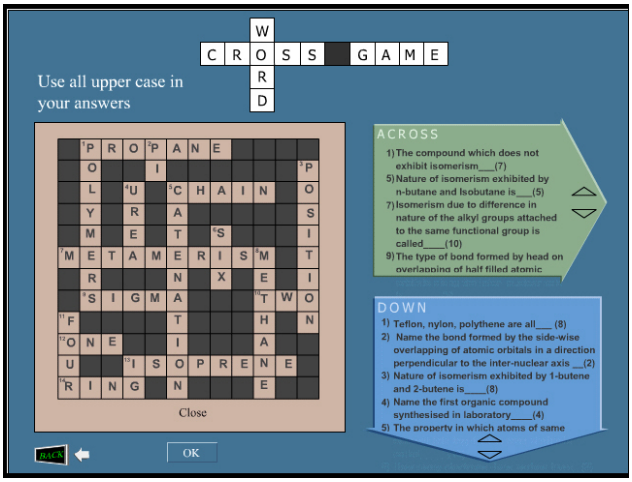


**Figure 3** Crossword Game - Topic wise

### 3.4 Non-linearity --- Search, Keywords, bookmarks, Notes

**Search:** The student while going through the lesson can branch (take a detour) at designated points to delve more deeply into the subject for a greater clarity.

**Bookmarks:** WWK also provides the student with the ability to bookmark topics within a course. A student must explicitly state which topics he wishes to bookmark. He may also specify a short one-line description for the topic that he creates a bookmark for. The default description is the name of the topic. A student may jump to a bookmark at any time during the course.

**Notes:** Since only a single line description can be added in a bookmark, this is often insufficient for a student to keep track of his thoughts while going through a topic. A note-keeping feature has been provided for this purpose. Just like a student would carry a notebook to a class and note down points of interest, or things that he may want to look

at later, WWK provides students with a notepad like interface for adding notes to a given topic. Any number of notes may be added to a topic, and all notes for a topic are listed sequentially when requested.

Using the above-mentioned memory features, a student can move around the course in any order that he wishes. A student may move back and forth between sections, in essence, creating his own hyperlinks in the content. These are private to the student and are not reflected in other students' profiles.

### 3.5 Real world applications ------Explore

The implementation of the learned concept in the real world applications is clearly explained in the Explore link.

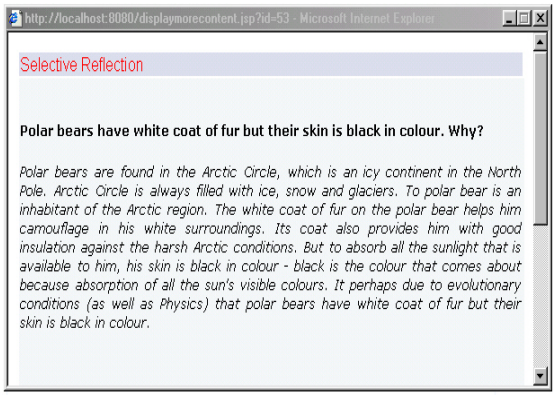


**Figure 4** Selective Reflection

### 3.6 Collaborative content development ---- File upload area

WWK enables subject matter experts, learners to participate in the course from varied locations through the 'File up load area' feature. The content manager sees the uploaded content and do necessary changes and include in the main course.

## 4. Simulations

An area where WWK has spent substantial time is in developing simulations for standard experiments. Since context and practice are two keys in retaining and applying knowledge, simulations provide a means for the student to have hands-on experience without the costs or risks involved in working in a "live" environment.

In e-Learning, simulations strive to recreate the student's work environment. They solve three primary purposes that regular lab experiments cannot provide.

- **Better visualization:** Experiments may not always clearly demonstrate what happens within the apparatus as it is closed. Students mostly see the end results. Simulations on the other hand can be used to demonstrate the effects in all stages.

  For example, a telescope has a lot of phenomenon taking place within the tube. In an live experiment, what the student sees is that object that is far off is appears at a reduced distance when viewed through the telescope.

  In a simulation, however, the image formation at every stage can be shown and the student can actually vary the distances to study the effect.

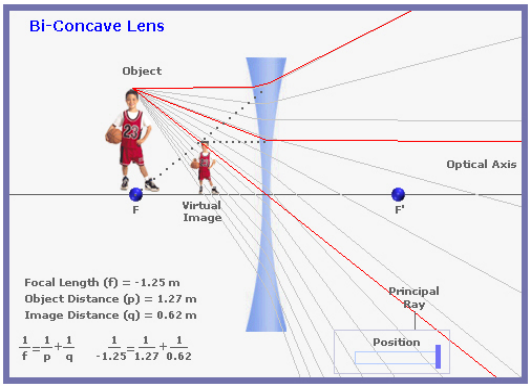


**Figure 5** Image Formation in Bi-concave Lens

- **Approximations and varying initial conditions:**

  In lab experiments, students aim is to reproduce the ideality and verify

the theoretical values. However, many a times the students will benefit and gain an overall understanding of the process if he/she can change the initial conditions or the environment.

For example, let us consider a refractive index experiment. Typical lab experiments are aimed at measuring the refractive index of a medium (water, alcohol or some other liquid). But, if the student must understand the effect of the density of the medium or the wavelength of the incident light on refractive index, constructing lab experiments will be extremely cumbersome and time consuming.

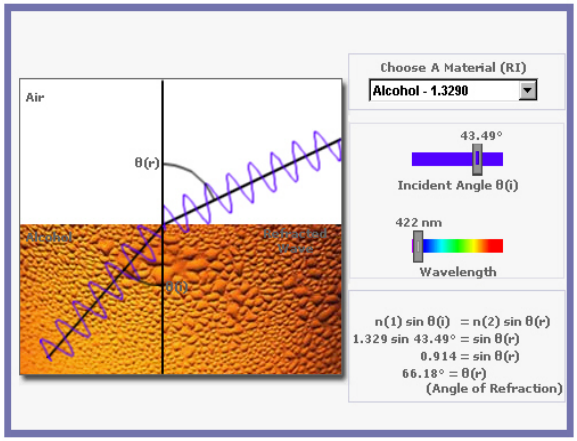


**Figure 6** Refraction of light in different Media

However, through a simulation these changes can be easily implemented and the student will gain the ability to approximate.

- **Experiments that are impossible to perform in real world:**

Conditions like absolute zero, frictionless surfaces can be very effectively simulated. These can never be obtained in real world and any experiment constructed is just an approximation.

However, a properly designed simulation can show the student how the motion gets closer to the physical laws he studied when the friction of the surface goes down.

This is also a great way to answer few of the simple but curious questions that students have.

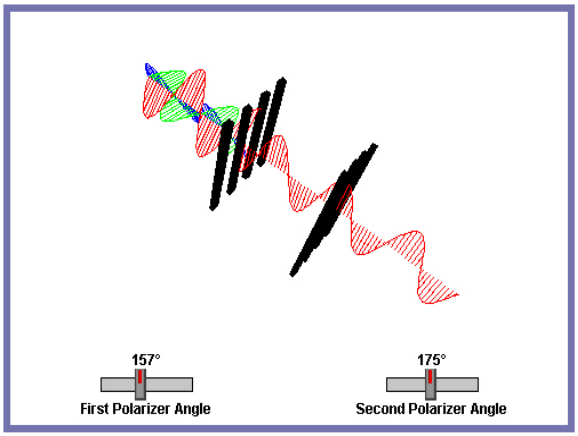


**Figure 7** Polarisation

A standard question that student has is as follows: Earth is moving at a speed. So, if I jump and some how stay in air for long enough, can I not just travel to any spot I want.

A simulation showing motion of earth and the weather around it and how the object revolves even if it is not in contact with the surface will explain such concepts clearly to the students.

All our simulations are applets. An applet is a little application. On the web, an applet is a small program that can be sent along with a web page to a user. E.g. Java applets can perform interactive animations, immediate calculations, or other simple tasks without having to send a user request back to the server.

## 5. Conclusions

E-Learning environment with application of e-tools like Flash animations, Java applets promotes visualization of concepts and help students gain insights through interactive simulations. Non-linearity in content

sequencing enables interactive, flexible learning along with application of concepts in everyday life through features like keywords, search and explore.

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