

# Visualization in Learning Mathematics with Hypervideo: *The Story of Pi* demo

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## ABSTRACT

Visualization has always been an essential aid in the communication of mathematics. It is an important way to concretize concepts, to develop abstraction skills, and to motivate learning, for example in topology and geometry, and in the application of numerical methods to simulations of the real world. Video has proven to be one of the most adequate ways to communicate visualization results, allowing to present in a rich cultural context a large quantity and diversity of information in a brief period of time. However, by itself, video has a limited capability to support learning. The structure and interaction introduced by hypervideo allow providing the user with greater control and autonomy, exploring links among the information conveyed by the video and complemented by other materials, augmenting its capabilities as a cognitive artifact. This demo presents *The Story of Pi* hypervideo, illustrating the ideas discussed in the paper “Visualization in Learning Mathematics with Hypervideo” [5].

## THE STORY OF PI – VIDEO

The *Story of Pi* video discusses the early history of Pi and shows how it appears in a variety of formulas and applications, many of which have nothing to do with circles, namely in probability problems. It is part of a series of modules, developed under Project Mathematics! [6], to introduce basic mathematical concepts in high school or community college, using live action, music, special effects, and imaginative computer animation that bring mathematics to life. The animation, together with images of historical documents and applications to the real world, grabs the attention of students and motivates them to want to learn more [1,2]. The video describes a sequence of improved estimates for the value of Pi, points out that Pi is irrational and explains that major improvements in the estimates for Pi represent landmarks of important advances in the history of mathematics. It uses different visualization techniques to present and illustrate various properties and applications of Pi, as exemplified.

## THE STORY OF PI – HYPERVIDEO

Hypertext refers to the true integration of video in hypermedia spaces, where it is not regarded as a mere illustration, but can also be structured through links defined by spatial and temporal dimensions. We have been exploring and developing different technological and methodological approaches for the design and construction of hypertext, with a special concern to the support of learning processes [3,4,5].

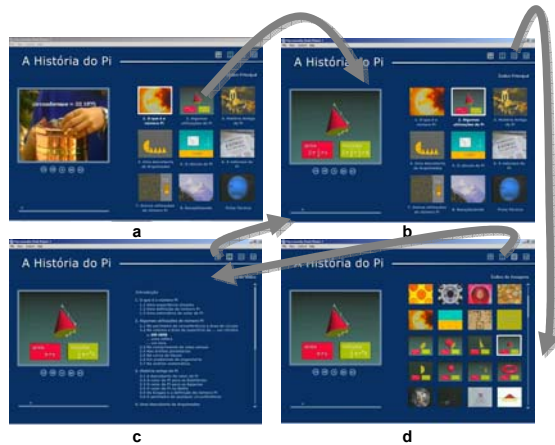


Figure 1 – Video indexes in the hypervideo:  
a) b) overview index; c) text index; d) image index.

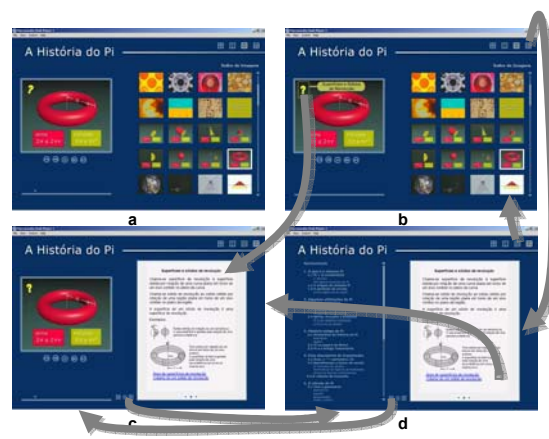


Figure 2 – Navigation in the hypervideo,  
integrating the video and the textbook.

The hypervideo developed for The Story of Pi structures and integrates the video with other materials, augmenting their individual affordances to support learning. Video can be navigated from different types of indexes that are presented in synchrony with the video. The textbook was converted into hypertext, respecting its underlying hierarchical structure, and further enriched with links involving text, images, video, and applications, allowing to capture relations among them and to illustrate or complement the information conveyed by each one. Figures 1 and 2 exemplify some features, presented in more detailed in [5]. The hypervideo is shown in the demo.

## ACKNOWLEDGMENTS

The authors would like to thank the support of FLAD “Fundação Luso-Americana”, CMAF-UL “Centro de Matemática e Aplicações Fundamentais da Universidade de Lisboa”, and LaSIGE “Laboratório de Sistemas Informáticos de Grande Escala da Faculdade de Ciências da Universidade de Lisboa” in providing the means for the development of this work.

## REFERENCES

- [1] Apostol, T., 1989. Project MATHEMATICS!- The Story of  $\pi$  – Program Guide and Workbook, CalTech, California Institute of Technology, Pasadena, CA 91125, USA.
- [2] Apostol, T., Blinn, J., 1993. Using Computer Animation to Teach Mathematics, CBMS Issues in Mathematics Education, V.3. 13-38.
- [3] Chambel, T., Guimarães, N., 2002. Context Perception in Video-Based Hypermedia Spaces. In Proceedings of ACM Hypertext'02, College Park, Maryland, USA.
- [4] Chambel, T., 2003. Video Based Hypermedia Spaces for Learning Contexts. PhD Thesis, Faculty of Sciences, University of Lisbon, Portugal.
- [5] Chambel, T., Santos, L., Nápoles, S., Rodrigues, J.F., Apostol, T., 2005. Visualization in Learning Mathematics with Hypervideo. Encontro Nacional de Visualização Científica, Centro Multimeios, Espinho, Setembro.
- [6] Project MATHEMATICS! at CalTech, led by Prof. Tom Apostol. [www.projectmathematics.com/](http://www.projectmathematics.com/)