Using AV – SIGCSE 2011

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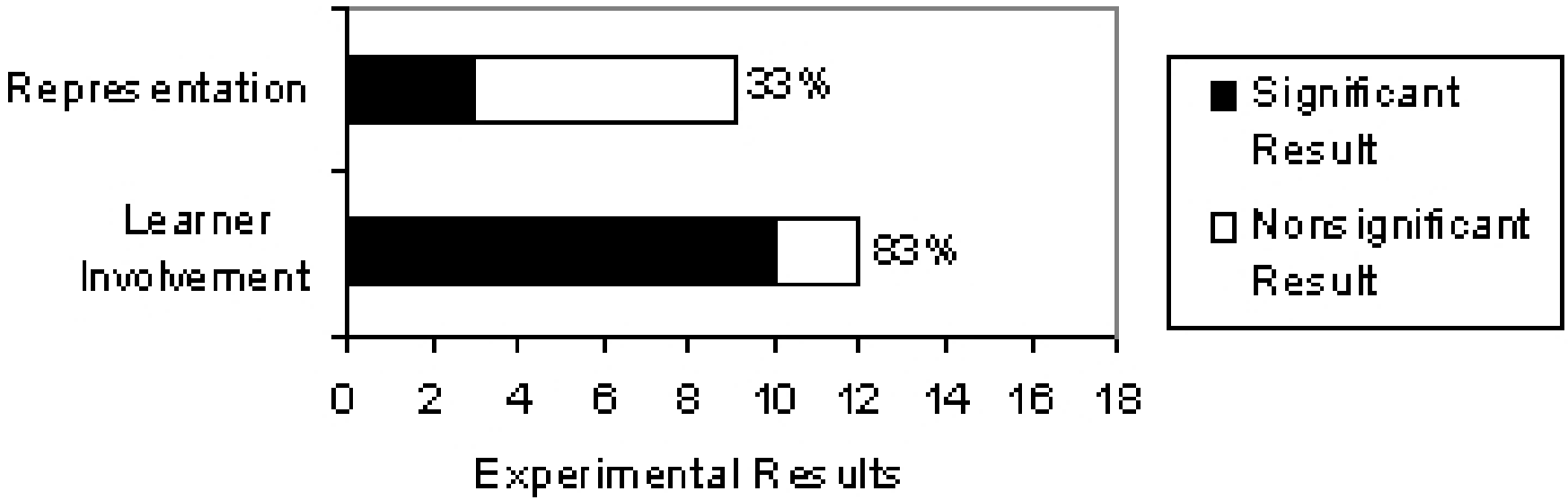
Is AV an effective aid to our students' understanding?

CS educators universally feel that it is – a survey of 98 attendees at ITiCSE 2002 found that 93% of them agreed or strongly agreed with the statement "Using visualizations can help learners learn computing concepts"

Is AV an effective aid to our students' understanding?

Research by Chris Hundhausen in his Ph.D. thesis at Oregon State Univ. (1999) shows that it is:



Hundhausen's research shows ...

It is more important for AV to promote active learner engagement than it is for AV to do interesting graphics.

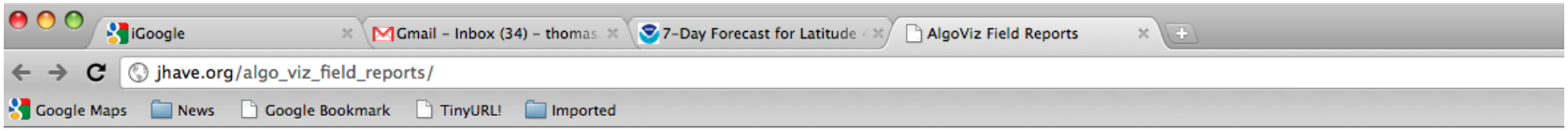
Hundhausen was part of the ITiCSE 2002 working group whose report identified four levels of learner engagement

- Respond
- Change
- Construct
- Present

Progression of uses of AV based on engagement hierarchy, based on samples of what we have at jhave.org – I

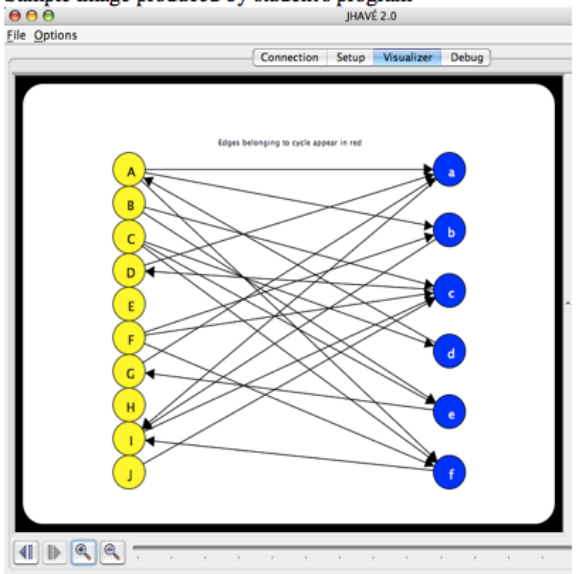
- Lecture aid
- Passive viewing
- Responding –
  http://jhave.org/learner/misc/sutherlandhodgman/sutherlandhodgmanclipping.shtml
- Changing –
  http://jhave.org/learner/misc/sutherlandhodgman/sutherlandhodgmanclipping.shtml
- Constructing
  - Have students code their algorithms using the GAIGS support classes (developed by Myles McNally of Alma College) and the algorithms will be automatically visualized – *http://jhave.org/developer/* and *http://jhave.org/developer/doc/index.html*
  - Go to *algoviz.org* and search for "deadlock"

Progression of uses of AV based on engagement hierarchy, based on samples of what we have at jhave.org – II



Code and other resources for field reports authored by Tom Naps at AlgoViz.org

- **Deadlock detection assignment**
  - Sample image produced by student's program



  - Code base students worked from

Progression of uses of AV based on engagement hierarchy, based on samples of what we have at jhave.org – III

- The more ambitious can check out the JHAVE repository at
  svn co *https://openalgoviz.svn.sourceforge.net/svnroot/openalgoviz/JHAVE/trunk*
  - Explore the *reu_bubsort* example to start your students on the way to constructing AV's with questions and synchronized pseudocode
- David Furcy's *jhave.org/JHAVEPOP*

- Presenting
  - Most of the AV's at *jhave.org* resulted from student projects.
  - John Stasko tried having his students built their own animations during an algorithms class at Georgia Tech. His conclusions:
    - Performance on final exam on questions about those algorithms was excellent
    - Anecdotal evidence that this helped understanding
    - Students spent a lot of time tweaking graphics
    - One of Stasko's main contentions is that Understanding an algorithm well handicaps you in designing an animation of it. We should learn from HCI and have learners as part of the design team for an AV

Progression of uses of AV based on engagement hierarchy, based on samples of what we have at jhave.org – IV

- Logging quiz results to help assess student understanding – *jhave.org/learner* Dijkstra's shortest path

Beyond its promotion of engagement, AV can become more effective if it does not "stand alone"

We have forgotten to read the caveat at the end of Marc Brown's 1989 ACM Distinguished Dissertation *Algorithm Animation*

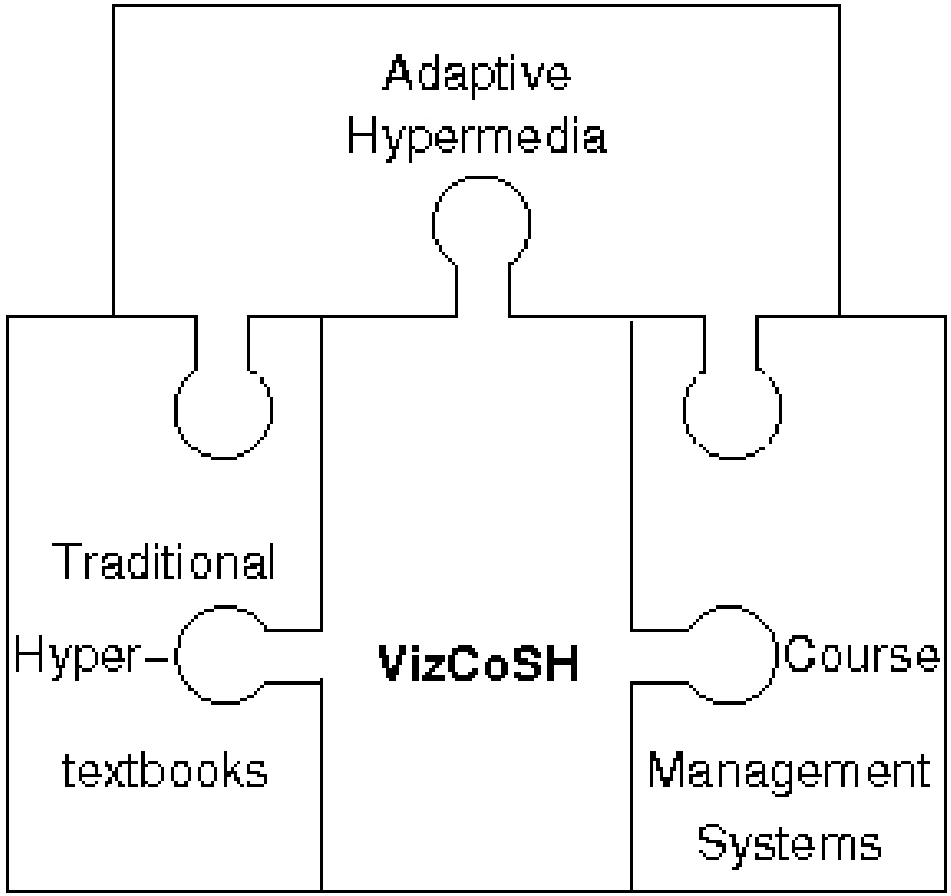
> *Much of the success of the BALSA system at Brown is due to the tight integration of its development with the development of a textbook and curriculum for a particular course. BALSA was more than a resource for that course – the course was rendered in software in the BALSA system.*

Students must see it as a natural resource to turn to in helping them understand an algorithm. For that to happen . . .

Cliff's hashing tutorial at Virginia Tech

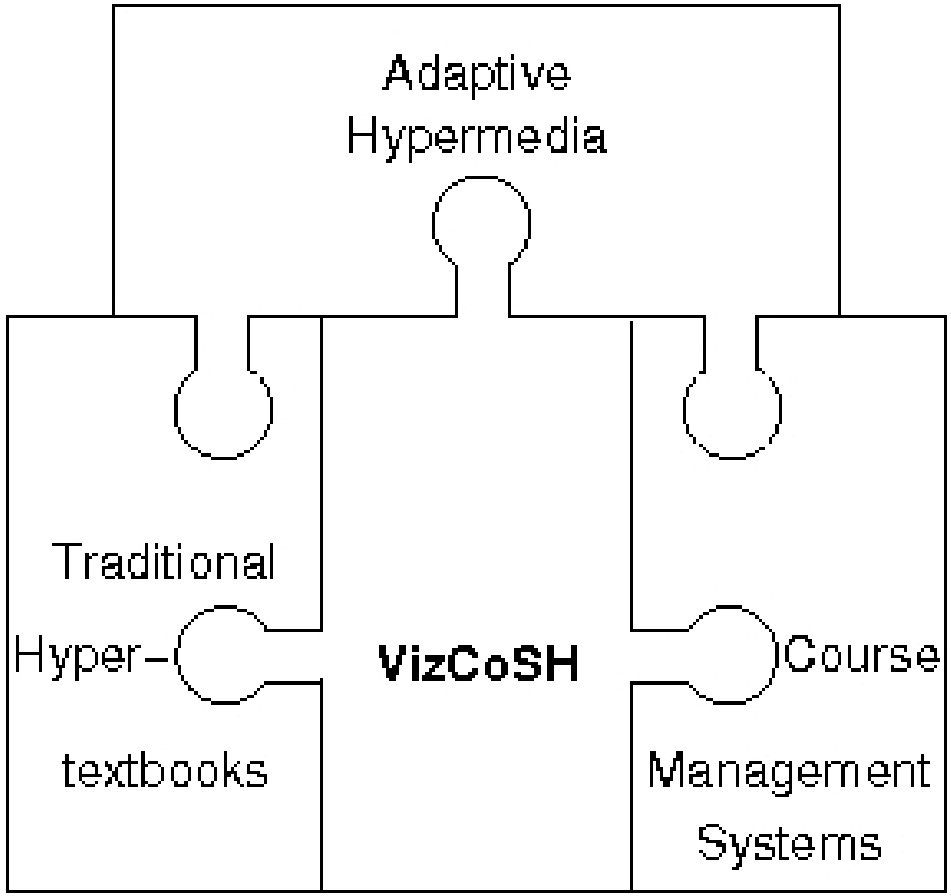
Visualization-based Computer Science Hypertextbooks – VizCoSH

- Text with significant connected structure, including a table of contents, chapters, and index
- Navigations that allow a student to self-select their pace through the material
- Navigations that lead to engagement-promoting visualizations



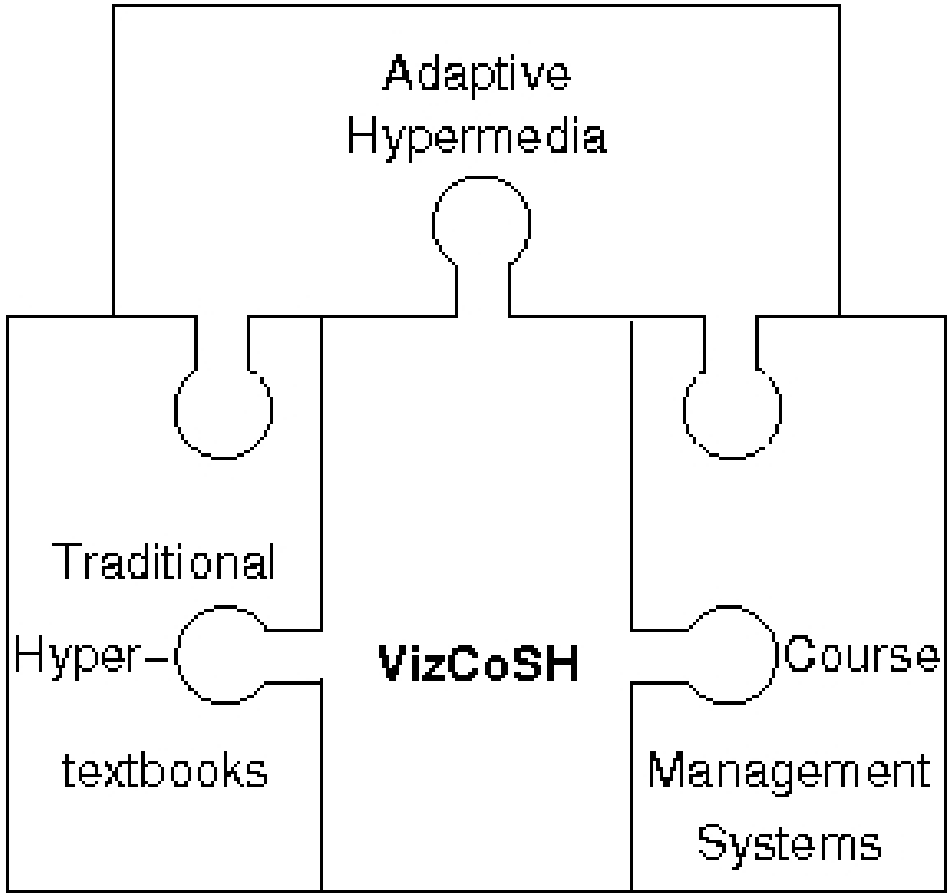
Visualization-based Computer Science Hypertextbooks – VizCoSH

- Log student use of the VizCoSH resources,
- Record student responses to assessment questions and activities, and
- Allow students to post their own additions and annotations to the VizCoSH materials



Visualization-based Computer Science Hypertextbooks – VizCoSH

- Adapt content to user's demonstrated knowledge level
- Suggest the best links to follow
- Balancing user-driven adaptation with intelligent guidance



Consider the following "typical use" scenario

A student is studying Dijkstra's algorithm

- Read the hypertextbook material
- Test their understanding of the algorithm's behavior by answering interactive questions during a visualization
- What should happen to the student's responses to the questions?
- What should happen to the visualization itself?

A "typical use" at the level of student construction and presentation

Based on a scenario created by Rainer Oechsle of Fachhochschule Trier – see R. Oechsle and T. Morth, *Peer review of animations developed by students*, in Proceedings of the 4th Program Visualization Workshop, Florence, Italy, 2006

A student is studying heap sort in a course conducted via distance learning

- Read the on-line hypertextbook material
- Construct their visualization of heap sort – How?
- Upload the visualization to the VizCoSH server
- Other students review the visualization, leading to
  - Increased communication and collaboration between students in a distance-learning situation
  - Improved skills at writing constructive criticism
  - Ultimately a more effective visualization