

A Formative Evaluation of the VITAL Tutorial
“Introduction to Computer Technology”

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Abstract

A formative evaluation of a multimedia tutorial designed to complement an introductory computer technology course was conducted by the Centre for the Study of Computers in Education. The tutorial, which was developed by the VITAL group of the CulTech Collaborative Research Centre, was designed for delivery over broadband, Web-based networks. Data were collected by asking students in the course to answer a brief questionnaire on whether they had used the multimedia tutorial, conducting focus group interviews of self-selected students enrolled in the course, and analyzing log files generated by the Web server hosting the tutorial.

Despite the relatively low overall usage of the VITAL tutorial by students enrolled in the course, those who did make use of it found that it was easy to navigate, flowed in a logical manner, and enhanced their interest in and learning of certain course topics. Students had a variety of suggestions for improving the modules, including page design modifications, adding humour and music to make some of the content less tedious, aligning the content more with the actual classes and text, permitting access to the tutorial from home (which is not feasible given current dialup services), and adding a communication link to the course instructor. The evaluation team concluded that if most of the student concerns were addressed, the VITAL tutorial could well serve to facilitate greater student understanding of course concepts and processes.

Background

In the fall of 1997, the Centre for the Study of Computers in Education was asked to conduct an evaluation of online tutorials being developed in conjunction with York University faculty by the VITAL group at the CulTech Collaborative Research Centre.¹ These tutorials have been designed for broadband network delivery, and include many interactive and multimedia components intended to enhance students' mastery of the subject by providing rich and varied learning opportunities not available in traditional lectures or tutorials.

As a first stage in the assessment process, a formative evaluation was undertaken of a nearly completed VITAL tutorial for the course *Introduction to Computer Technology* developed under the direction of Prof. Peter Cribb. This course, a required component in the undergraduate programs of several non-Computer Science majors, has been taught in a more traditional manner by Prof. Cribb and others as Computer Science 1520.03. In consultations with CulTech faculty and staff, it was decided that for the purpose of initial field trials, the VITAL tutorial would not be offered as a stand-alone entity, but would be made available to those students in all three of the winter 1998 sections of 1520.03 offered who wished to use it as a supplementary unit. Students were given access to the VITAL materials in the Glade computer laboratory during normal operating hours.

¹ This project was funded by the Office of the Vice-President (Academic Affairs). The opinions expressed in this report are those of the authors and do not necessarily represent those of York University.

Objectives

The primary goal of this formative evaluation was (1) to provide the Course Director and the VITAL development team at CulTech with information regarding the uses students made of the VITAL tutorial during the trial period, (2) to provide these stakeholders with an analysis of students' experiences with and responses to the online tutorial; and (3) to make suggestions for program modification on the basis of this data and analysis.

Evaluation Design and Procedure

At the class sessions in which the course lecturers announced the VITAL tutorial and told students how it could be accessed, members of the evaluation team solicited student volunteers to participate in focus groups. Students were informed that various aspects of their experiences with the online tutorial would be discussed, and a \$20 York University bookstore gift certificate was offered as an inducement to participate. Students willing to participate completed and returned an informed consent form. Approximately 30 students initially volunteered.

Four focus group sessions were held on campus during the week prior to the final week of classes. Two weeks before this, student volunteers were contacted via mail and telephone to confirm their placement in a focus group session. A day or two before their scheduled group session, students were contacted again to remind them of the time and location. Ultimately, a total of sixteen students showed up and took part in the groups. Each session lasted between one half-hour and one hour in length. The focus group leader followed a semi-structured interviewing protocol which probed students' attitudes and reflections about all

aspects of their use of the VITAL system. The group sessions were audio taped and transcribed and then qualitatively coded, with indexical counts being developed where possible.

In order to determine the degree of use of the tutorial by those not participating in the focus groups, a brief questionnaire was distributed to all students attending lectures in the penultimate week of classes which asked students if they had accessed the VITAL multimedia tutorial, and if so for how long.

To focus more precisely on the patterns of use of the VITAL tutorial, the Web log file generated by the Netscape Web server used by CulTech was analysed using the Webtrends log analysis software. This log file keeps detailed records of student accesses, making it possible to refine an analysis of student usage considerably.

Tutorial Usage

One hundred and fifty-five students answered the usage questionnaire, which represented approximately half of the total number of students registered in course. (The remaining half of the students were not in attendance in their classes when the questionnaire was distributed.) The first question asked was: "Have you ever made use of the VITAL multimedia tutorial for this course?" One hundred and twenty-four students answered "No" [75%], 31 "Yes" [25%]. The second question was "If yes, how many hours have you spent working on it?" Students responded by selecting a category of usage. To this, 7 students [23%] responded "less than 1 hour"; 9 students [29%] 1-2 hours,. 5 students [16%] answered 2-3 hours; 6 students [19%] answered 3-4 hours; and 3 students [10%] answered 4-5 hours. One student indicated a use greater than 5 hours.

Web Log Analysis

The Webtrends report indicates that students made heaviest use of the tutorial during the week of March 29, just prior to the days in which the focus groups were held. Informal inquiries of the participating students indicated that most undertook their online work with the tutorial in the few days (and occasionally hours) prior to attending their group. In the four weeks prior to this usage was approximately 1/2 as high (as indicated by the volume of activity report). In the first weeks following the discussions use was also about 1/2 as high, suggesting that a few students were making use of the tutorials for exam preparation. Overall, the use distribution over time when taken together with the class usage survey data suggests strongly that at least half of the tutorial use was by students who participated in the focus groups.

Data on the most and least frequently accessed pages from the Webtrends report indicates that most students' use of the tutorial was far from comprehensive. This data together with the data on the paths most frequently taken through the site indicate that two usage patterns predominated. In the first, which might be termed *exploratory browsing*, students first worked their way through some of the introductory material and then looked at pages in one or two of the other sections (Hardware or Software – History material was very rarely accessed.). Sometimes this order was reversed. About one third of the time these students would *only* look at introductory material. When exploring a tutorial section, most students did not seem to go much beyond the introduction to and/or the first page for the major section: for example, in the Software section, a student might select the Operating Systems subsection, reading the Introduction and then the top level of the “Main Functions of an Operating System” division without “drilling down” into any of the additional material accessed via the vertical

navigation bar subheading on the left side of the screen. Very little use was made by such students of these “level four” subcomponents; they preferred to wander over various areas, “browsing” the elements at levels two and three.

The second usage pattern that can be discerned from this data was shared by approximately 45% of the users (versus about 55% for the first pattern). These students did not spend time with introductory material; they proceeded directly to work with resources in one (or infrequently two) focussed domain areas – accessing, for example, several related pages on data representation in the Hardware section. These students were more likely than those in the first group to access level four information via the left-hand navigation bar, but even here the majority of pages retrieved were at higher levels. Of the 34 pages visited a total of 20 times or more (summed across all students), only five were level four pages. Use of level five resources (accessed by a highlighted name and number bar embedded lower in the page) was extremely rare.

Of the 50 most frequently visited pages, nine were in the Introduction and History section; 17 in the Software section; and 24 in the Hardware area. Table 1 below provides a further breakdown of these figures.

Table 1
Fifty Most Frequently Visited Pages by Subject Area

Subject Area	% of Total
<hr/>	
<u>Software:</u>	
Programming Languages	24
Operating Systems	8
Software Engineering	2
<u>Hardware:</u>	
Digital Logic	6
Data Representation	30
Computer Architecture	12
<u>Introduction</u>	14
<hr/>	

The least frequently requested pages fell into several categories. Several graphic images and movie/video clips were only retrieved a few times. Pages with decoder and converter animations or toolkits, history materials, and pages dealing with boolean operators received slightly more attention (6 to 12 visits in total). Aside from the graphic and video elements, nearly all the pages retrieved less frequently were at the fourth or fifth levels of the Web site structure.

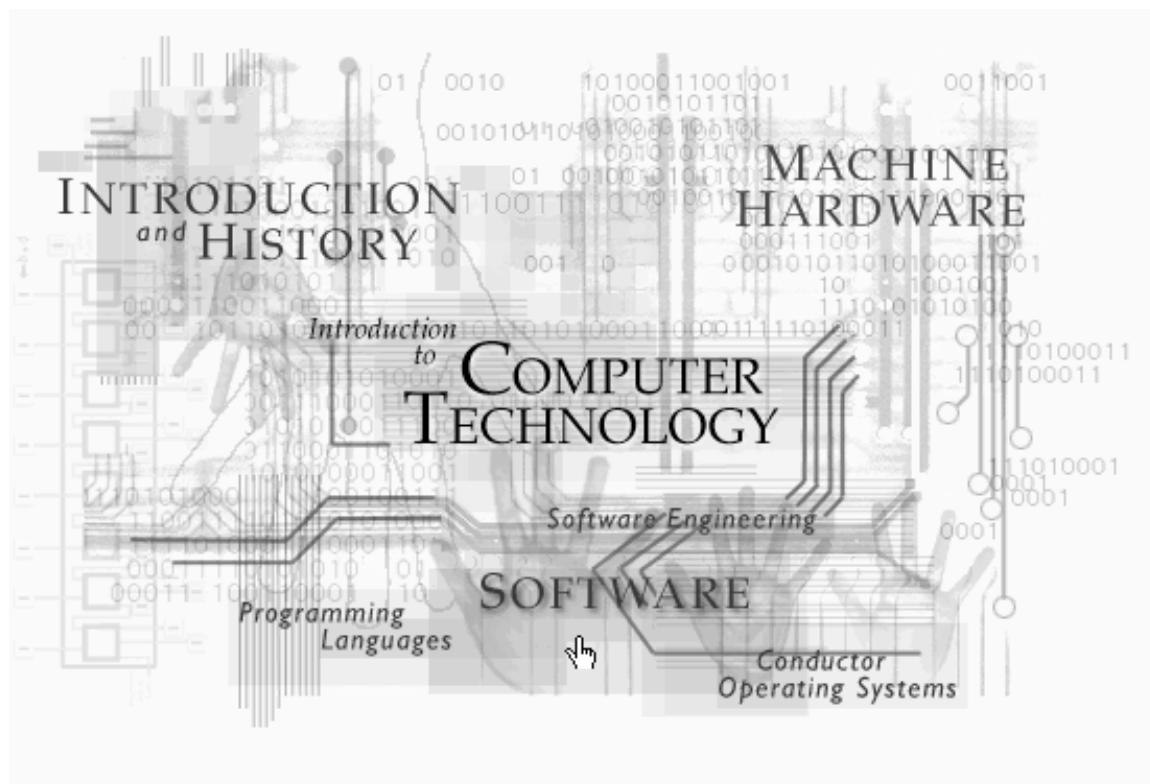
It is worth noting that Webtrends reported a significant percentage of failed hits, a source of some concern on the part of the students. Twenty-two hundred failed hits were noted, 12.4% of the total attempts, with all of these failures being 404 errors (page or file not found). Only four internal server errors were reported.

Using the Tutorial: Student Perspectives

Ease of Navigation and Use

When asked how easy it was to use the VITAL tutorial, all of the students indicated that it was “easy” or “very easy”. The system responded well, and the speed of navigation was appreciated. Further probing indicated areas in which the students found the interface and navigation tools to be less than optimal, however. Many of the students indicated that the main entry/heading page was confusing, since moving the mouse cursor over a top-level heading on this page

like "Software" highlighted the entire set of related subtopics (e.g., Software Engineering, Programming Languages) despite the fact that mouse clicks on a specific subtopic took the user directly to that subtopic. (See screen shot below.) Lacking specific visual cues, students did not realize where they were being led. One student stated, "The first time I looked at it, I thought I was getting the whole subject and then I found out that if you go in that little bit on the side, there is the little link." Several participants suggested that only the relevant subtopic below the mouse pointer should highlight.



This Course

Themes and Concerns

Conclusion

Intro

Computer as a Tool

Computer as a Media

THEMES AND CONCERN S

This second part of the introduction takes a brief look at the debate raging in our society about the impact of computer technology. It is intended to motivate the study of computer technology, as a means of better understanding the beast outside our gates.

The study of the impact of computers is a field of academic pursuit in its own right, as well as being the subject of numerous books published for a popular audience. One need only mention the names Clifford Stoll ("Silicon Snake Oil"), Nicholas Negroponte ("Being Digital") and Stephen Talbott ("The Future Does Not Compute"), for example, for most people to instantly recognise the genre.

Task : Explore briefly the material available on the WWW related to one of these authors. Go to the Web search engine [AltaVista](#) and perform a search with keywords being the name of one of the authors. You can simply click on the word AltaVista to "go to" the search engine.

Some users reported difficulty in figuring how to return to the top entry page since it wasn't intuitively obvious to them that they should click on the main heading. Several did get back to the top directory page without knowing how they had done it.

The tutorial's hyperlinks also confused some students. Many commented that the links to other web pages and resources should be blue and purple (as they are used to on the Net). The links in the tutorial were green and yellow and it was difficult for some to determine which links they had used and which they had not. A further frustration several users noted was a significant number of "dead" links that went nowhere.

A design element that worked well for this group were the arrows on the top of some pages indicating that there was more information (i.e. subsections) to come.

Perceptions of Design and Multimedia Utilization

All of the interviewed students felt that the tutorial flowed well and was organized in a logical manner. There was a strong consensus that the VITAL text “read” better than the course textbook, and was easier to understand. About 85% of the participants thought the general balance between text and other multimedia elements was appropriate. Still, many students felt that some portions of online text were too long and could be more efficiently read if the text was broken up by more graphics, animation or videos. Some students felt that examples would help them understand the material more effectively. One student commented “I don’t know if it gives any examples of the codes, the binary stuff. I didn’t see any examples; I need examples to show continuity and the context of what happens.”

Seventy-five per cent of the focus group participants felt that the interactive elements such as the binary switches and the multiplexor were helpful, while 25% found some of the switches “a little” confusing. One student who had problems noted, “Oh, that was the one that didn’t work; where the binary codes...where you’re to do ‘one, zero, zero’. I put in a zero at one point and it didn’t do anything. It didn’t take the zero. So I didn’t know what was going on.” One student felt they were useful but had a caveat: “Very effective. Easy to understand. Switching between them takes a long time. I don’t know why, but if you click on a circuit, it takes a long time to process. I don’t know why but it does. But colours are good; the visual display is good and it [gives you a good understanding]. It’s clear and concise...” Another student felt that the diagrams would have been easier to understand if they were accompanied by voiceovers:

"I think to me it would be able to do it at the same time, like it's the actual content that's read to you and while it's happening, the diagram would go at the same time and show what was happening. So if you clicked on one, for instance it would say, 'The numbers are changing now, because of'...and explain." (It appears that many students did not realize that audio support was available for some of these activities (see discussion of audio below).) A few students thought there should be additional interactive elements in the tutorial to differentiate it more from a textbook. One student remarked: "and this way [if there's a lot of text] I will have my eyes strained as much from the computer monitor glaring at me. I think that if more interactive exercises were incorporated into the text on the system, less text and more exercises, it would give people more incentive to go to the lab and try it out. By the way, people like that, having a lot of fun on the computer system and having feedback from the computer system and...that's one of the key differences with the textbook and the computer system. You know the textbook can't give you interactive feedback like that."

Because the Glade lab was not equipped with headphones at the time of the trial, only those few students (about 6%) who had their own earphones and figured out how to plug them into the computer heard any of the audio from the video or audio clips. Many students suggested having headphones in the lab for student use. They could be "rented" in exchange for one's student card. Students also suggested that the video clips have an "off" button: Because they couldn't hear them, students wanted to move on to another part of the tutorial but were unable to do so because they couldn't stop the video. And when students used the tutorial more than once, they didn't want to have to sit through the videos a second time. Several participants noted that some video segments were very "fuzzy".

Perceptions of the Tutorial's Educational Value and Utility

Three quarters of the students said that the online tutorial enhanced their learning in certain topic areas. A typical comment: "It's educational, It gave you a lot of insight into theory." A substantial minority of participants saw their tutorial experience as heightening their interest in the course content. One student had this to say: "I think it enhanced my interest, in terms of future projections. It had a section on computer programming and software where they list several programming languages and so on. I think I got some interest to study more."

The discussion and activities relating to binary arithmetic and binary switches was most often cited as a useful part of the tutorial. All of the students said they had worked with some part of this material and 87% indicated that they found it interesting and useful. Other areas mentioned as useful by at least a few students: machine hardware, math code, operating systems, and computer functions. Many students remarked that the links to other sites were interesting, although there was criticism by a few that some of the linked articles were far too long to be readable (the Postman article was mentioned in this regard).

The tutorial appeared to have little impact on students' lab experiences. Not one student felt that it affected their work on lab assignments, primarily because the labs covered topics not included in the VITAL materials. Most specifically mentioned that the tutorial did not deal at all with Excel, which was extensively used in the lab. The situation was little different for studying for tests and exams: about 20% of the participants felt that the tutorial had an impact there. Although many students did not yet know if their marks were affected by the use of VITAL, a few thought that their studying experience was enhanced. One student

had this to say: "Yes, it's a good review; it is a pretty concise review for exams. I think it will be helpful." Another student noted, "I went in for the binary stuff I knew I didn't know how to do. So I went in for that specific reason and it helped me with that. I'd probably use it just to get more information that the book won't give me."

Many students, like the one just quoted, saw the online tutorial as a good supplementary resource (in addition to their textbook) and felt it helped to solidify their knowledge of material of which they were somewhat unsure. If the lecture time was not enough to give them a firm grasp of the information, they felt that they could use VITAL to learn at their own pace.

Many students also felt that it was more interesting to read from VITAL than from a textbook. One student explained, "I think it's more interesting to be actually working on a computer rather than the textbook and highlighting all the material, because most of the important things are already highlighted or underlined [in VITAL]. I would prefer actually studying on a computer, because you can click on different buttons and you can just concentrate on the areas you want to concentrate on."

Sections of the tutorial dealing with binary arithmetic and algorithms were cited by 88% of the participants as enhancing their interest and improving their understanding of the topic. The tutorial was also thought by 75% to be an aid in practicing skills that might not be as secure as the students would like them to be. One student explained it this way: "You actually get to try it out whereas when you're writing, there are so many different mistakes you can make and you don't know where you've made the mistake and the computer helps you to

figure out where your mistake was and guides you step by step through the process."

When asked about the prospect of substituting the VITAL tutorial for part or all of the traditional lectures, all of the students said that this was not desirable, although there was no clear rationale given for preferring to stick with the lecture format. The great majority (88%) thought the tutorial would serve as an effective supplement that would aid their learning. Three quarters of the group appreciated the individualization the tutorial made possible, citing the ability to work with it "at their own rate". They felt that sometimes the class lectures went too fast for their ability to intake information. The tutorial allowed the student to go over material more than once. In addition, two thirds of the participants felt that the online tutorial was less boring than listening to a professor speak for long periods of time.

Another improvement that many students brought forward concerned developing a closer correspondence between the tutorial and the course, so that students could see more directly the relationship of tutorial sections to text chapters, lecture topics, and tests. It seemed students found the sessional lecturers made no attempt to connect the two, or to encourage tutorial use. A number of students expressed interest in the professor explaining VITAL at the beginning of the semester, discussing the main features and perhaps giving a handout to students. Other students thought that there should be assignments on the VITAL system that would be handed in for marks. Over 90% thought that the tutorial would be more effective if it was supplemented with some kind of communication link, such as email, to a tutorial leader. It was thought this would make it more interactive and therefore more effective.

All of the students thought that the VITAL tutorial was “a good idea” and that it had great potential as a learning tool. One student said, “I wish all my classes had something like this. It’s really a new way of teaching and I think its very exciting and there [are] a lot of things that this could lead into and improve teaching.”

Suggested Improvements

When suggestions for improving the tutorial were solicited, the participants had a wide range of ideas, some shared and others unique. In addition to modification proposals discussed so far, the following recommendations were made. (Where substantial numbers of students made the same proposals, this is noted):

- Add humour and/or music whenever possible to make use more pleasant. One student noted that “Music can sometimes be very stimulating in terms of studying.”
- Restructure VITAL to better fit class schedules so that studying, etc. could be made more effective. For example sections of VITAL could list the classes or chapters of the text with which they correspond.
(Two thirds of the students supported this change)
- Add a “back to top” button at the bottom of page.
- Add quizzes where answers are provided or returned via email.
- Add a glossary to the tutorial.

- During videos have Peter Cribb (or other Professors) use visual aids, i.e.: blackboards, overhead computers, show computer parts.
- Use larger fonts to reduce eyestrain
- Make VITAL accessible from home. (All students desired this feature.)
- Use Canadian spellings for words like “realise”.

Evaluation Team Recommendations

The generally positive feedback the tutorial received from the focus group participants must be balanced against the usage data, which indicates that few users made more than brief forays into the tutorial. Aside from the title page, only 10 pages received more than one visit per student user, and large numbers of pages were visited by only a minority of those accessing the materials. While it can be reasonably inferred from the collective usage data that several of the volunteer student focus group members explored the tutorial in greater depth, they were offered an incentive to do so, and they constituted only about 5% of the total student population in the course sections. In light of the fact that the interviewed students considered the tutorial to have significant potential for enhancing learning, it is important to consider what changes might be made to foster more extensive use. For the students, the most central issue was increasing the relevance of the tutorial to performance in the course, and they suggested several ways this could be done: having lecturers make direct reference to VITAL tutorial elements addressing curriculum being presented in class on a week-to-week basis; having lecturers explain the tutorial more fully in class and demonstrate its use; and have the tutorial itself “indexed” in some manner to the course and/or the textbook chapters so that users could quickly access resources

relevant to their study needs. Another means for tighter integration would be to test students in class on certain aspects of the tutorial material that are not presented in class. As students were not in favour of having the lectures replaced by the online component, that option does not seem tenable at the present stage of the course's evolution. A more viable approach to making the tutorial more salient would be to allow users to interact with tutorial assistants when working through elements where they required additional pedagogical support, via either online conferencing or email.

The second major barrier to utilization that needs addressing is the lack of ready access to VITAL. Students clamoured for dialup access. The Centre's evaluations of other forms of online tutorial have found that the elimination of the time and location barriers to accessing tutorial materials that remote availability facilitates has been found by students to be the single most important benefit of the systems. Unfortunately, current dialup technology does not support sufficient communications speed to allow convenient access to the multimedia features of VITAL. Cable and ADSL are two relatively new technologies that would allow remote access at sufficient speed, however these are not available in all geographic areas and they are more costly. Another possibility is to distribute VITAL on CD ROM and have students use the CD in conjunction with regular dialup modems to access links to Internet resources.

A significant frustration for the majority of users was the lack of audio output when attempting to listen to the audio and video clips. This can be easily remedied by providing the lab with headphones to be "signed out" as needed. Access to the audio elements could help to address some of the confusion engendered by certain interactive elements, since these students had no chance to hear the accompanying audio explanations.

Less important, but still significant, are the issues of site design and navigation that were raised by students. Dead web links need to be updated or deleted, and changes made to some of the navigation cues to make their function more readily apparent. Specifically, the fourth and fifth level access cues need to be clarified, either by making their function more obvious by design modifications (placement, size, colour and highlighting), by providing relevant explanatory material at the main entry level of the tutorial, or by simply labeling the cues as needed (e.g. placing “Subtopics:” above the level four headings).

The longest text passages either need to be edited down to avoid intimidating potential readers, or else be broken up by the addition of more graphical or interactive components. Link usage should be indicated in customary ways so as not to confuse users about what has already been accessed. Rollover highlighting with the mouse should be limited in scope to the specific function that will be activated by clicking at that point (such as linking to a particular subsection).

In conclusion, it bears repeating that nearly all of the students thought the online tutorial could make a significant contribution to mastering the course content, and many commented that it heightened their interest in the topics being covered. If the limitations to access discussed earlier can be overcome and the minor interface problems corrected, there is every reason to believe that this VITAL tutorial could help students develop a deeper understanding of the computer concepts and processes being taught.