

Forth and Computer-Assisted Instruction (CAI) II.  
The Role of Forth in Formative Evaluation  
of Instructional Materials

by

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Abstract

In 1986, a Computer-Assisted Instruction (CAI) tutorial on superelevation was written in Forth for the Department of Landscape Architecture at The Ohio State University. Later that year, it was used in the research phase of a Ph. D. dissertation: Formative Evaluation Subject Selection: FD/I Cognitive Style. The study investigated learning style as a criterion for selecting students for one-to-one formative evaluation of learning materials.

The original superelevation tutorial was revised based on evaluations by students previously classified as field dependent/independent (FD/I) using the Hidden Figures Test (HFT). A class of 46 junior-level students classified as FD/I were divided into equal groups as control, original tutorial, and revised tutorial. All groups received the same post-test.

The author of the tutorial is highly field-independent, and of students taking the original tutorial, FI's scored significantly higher than FD's. Of students taking the revised tutorial, there was no significant difference between scores of FI's and FD's and both groups scored significantly higher than either group taking the original tutorial. Despite a substantial increase in the amount of material in the revised tutorial, study time remained constant.

This poster session will include a 35mm slide presentation discussing background to the development of the original tutorial and differences between the tutorials resulting from the formative evaluation. The role of Forth, both in the original (PC/FORTH 3.1) and revised (UR/FORTH 1.0) tutorials, will be emphasized.

## Background.

During Winter and Spring Quarters, 1986, the author began work on a Computer-Assisted Instruction (CAI) tutorial on superelevation, the banking of highway curves. The language used was Laboratory Microsystems, Inc.'s PC/Forth 3.1 with floating point and EGA graphics extensions.

In August, 1986, the author was approached by Dr. Christian Chinien who then was working on his dissertation research proposal: Examination of the Cognitive Style Construct Field-Dependent/Independent as a Student Selection Criterion In Formative Evaluation. Dr. Chinien hypothesized one or two selected individuals could give "feedback" about instructional materials under development, as valuable as that produced by a larger group of evaluators. His study dealt with a single criterion for selecting the individuals: the psychological construct field-dependence/independence (FD/I).

Field-dependence/independence is a learning style. Field-dependent persons tend to learn better by moving from concrete instances to a conceptual understanding, while field-independent persons tend to learn better by moving from concept to specific examples. For example, by understanding many trees, FD's come to understand the concept "forest." FI's tend to grasp the concept "forest" quickly and use it to understand many individual trees. An instrument frequently used to identify field-dependence/independence is a timed test in which subjects are asked to find simple geometric shapes within complex geometrical figures.

Dr. Chinien suggested using the superelevation tutorial for his study. He would classify all subjects as FD/FI, conduct the formative evaluation, summarize required changes to the tutorial, conduct post-testing of the subjects, and develop an attitude questionnaire. The author would be responsible for all programming changes resulting from the evaluation. A post-test would be jointly developed.

The major problem was time. The study had to be completed by the end of Autumn Quarter (Christmas), and could not be begun before the quarter commenced in mid-September. In the interim, the original tutorial was "completed."

## The Study.

The junior class in Landscape Architecture (n=46) was given the Hidden Figures Test (HFT)<sup>1</sup> and classified as FD/I. Two FD and two FI juniors were selected to evaluate the tutorial. Each student worked through the tutorial at

his/her own pace, while Dr. Chinien took notes, asked questions and recorded the session. Based on their comments and suggestions, Dr. Chinien prepared a list of revisions.

A post-test covering the tutorial content was developed and given to the senior class which had covered the material in the previous year. Based on the senior class test results and discussions with other content experts, the post-test was revised somewhat.

Members of the junior class were separated into groups: control, original tutorial, and revised tutorial. Students spent between forty-five minutes to an hour reviewing a tutorial before taking the test. After the test, each student taking a tutorial filled out an attitude questionnaire.

### Results.

Of students taking the original tutorial, FI's scored significantly higher than FD's. The author of the tutorial is highly field-independent and the original tutorial was biased toward his preferred personal learning style. The formative evaluation resulted in a more style-independent tutorial. Of students taking the revised tutorial, there was no significant difference between scores of FI's and FD's and both groups scored significantly higher than either group taking the original tutorial. Despite a substantial increase in the amount of material in the revised tutorial, study time remained constant.

"The main conclusion drawn was: a material revised on the basis of feedback generated by FD and FI students is more effective than its prototype, and narrows differences in achievement between FD and FI students. Qualitative conclusions were also drawn from the naturalistic formative evaluation."<sup>2</sup>

### Forth as a CAI authoring language.

As you might suspect, much of the tutorial consists of text which is formatted to windows on the display. Because the author wanted to integrate graphics with text, simply listing blocks of text from disk to the display was rejected. The tutorial's branching system required backing up to previously viewed "chunks" or sequences of animation and/or explanatory text. These design goals suggested either memory overlay residence of the entire tutorial or some form of binary overlay structure. The initial decision to use PC/FORTH instead of a Computer-Assisted Instruction (CAI)

authoring system was to allow the use of multiple fonts and animation of objects in the tutorial, using high resolution EGA graphics (640x350 pel, 16 color). PC/FORTH also supported binary overlays.

As the original tutorial grew in size with revisions and additions, editing in PC/FORTH's 64k workspace became "UCSD Pascal-like." Fortunately, LMI released UR/FORTH for beta-testing just as the deadline for completing the project approached. Conversion from PC/FORTH to UR/FORTH was a ten minute port. The entire tutorial including objectives fit in 256k RAM easily, and overlays were not required.

The original tutorial consisted of 78 screens of PC/FORTH source. The revised tutorial comprised 98 screens of UR/FORTH source. The difference in file size alone does not indicate accurately the extent of the modifications required to implement the changes, however. While some modifications were simple word changes, others involved completely redesigning the displays and animation.

#### Summary.

The advantages of Forth for CAI are the advantages of Forth for any application. Formative evaluation is an essential process in creating effective CAI; and Forth, although not thought of as a CAI authoring system, makes the required revisions an order of magnitude simpler for complex graphic displays.

#### References:

<sup>1</sup>Ekstrom, R. B., French, J. W., Harnan, H. H., and Dermen, D. (1976). Manual For Kit of Factor-Referenced Test. Princeton, NJ. Educational Testing Service.

<sup>2</sup>Chinien, C. A. (1987). Formative Evaluation Subject Selection: FD/I Cognitive Style. Unpublished doctoral dissertation, The Ohio State University, Columbus.