Rate of Activity Completion by Achievement, Sex, and Report in Computer-Based Instruction

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Abstract

In an intact third grade class (n=27) that has had extensive CBI experience, correlations (multiple R = 0.68) were observed between the criterion variable rate of CBI lesson completion and the predictor variables achievement and sex. The relationship between achievement and rate appears non-linear. Also, boys (+.38 s.d.; above class mean) showed faster rates than girls (-.48 s.d.; below class mean). Additionally, students appear to exhibit stable characteristic rates of response across different CBI content. Finally, providing progress reports as classroom wall charts appears to speed up the lower ability students' rate while middle range students' rates seem to slow down relative to their previous rate and the class' norms. Rate data which is easily available in CBI is a much overlooked student variable. Such data may prove to be a potent variable in truly individualizing instruction with interactive systems.

Computer-based instruction (CBI) generally utilizes mastery learning concepts. Usually, students progress at their own pace through a linear sequence of activities that make up a lesson. If the student has difficulty at a certain point in the lesson, some type of branching option or review is offered. This assists the student through the difficult section and then provides a retest to determine whether the student achieved mastery on the second try. The student is awarded the score on the most recent retest, and since typically, mastery is set at 80%, no student can advance until they have reached or exceeded this criterion level. Students are rewarded by being allowed to begin the next lesson in the sequence (Striebel, 1986). In this way, CBI converts normally distributed grades (e.g., A,B,C,D,F) into variable lengths of time which also are assumed to be normally distributed (Bloom, 1971, 1976).
The amount of time required by a student to complete a CBI lesson activity would be composed of at least two parts. First, the program sequence itself requires some minimum or base amount of time to page through all of the frames. Branching due to incorrect answers will increase the total number of screens thus also increasing the individual base amount of time. Second, the learner reads and responds to each frame based upon "self" variables. This second variable might be referred to as self-pacing. In most CBI, self-pacing is allowed, and in many cases, self-pacing is the only instructional variable under the control of the learner.

CBI has the potential to be a true individualized form of instruction (Ross, 1984; Spock, 1987), but if self-pacing is the only variable controlled by the learner, this hardly classifies as individualized instruction (Bork, 1984). On the other hand, since self-pacing is under the control of the learner, this variable may contain valuable information about the learner and the learner's response to the lesson content.

Student data collected on-line in CBI has many possible uses (Allessi and Trollip, 1985). Computer generated reports of a student's progress in a computer lesson are used by the teacher and by administrators for evaluation and remediation. Additionally, reports may be used by the student to evaluate their overall progress and may serve a motivational factor affecting future learning behavior. For example, providing eleventh grade at risk students with reports of their individual progress in a CBI based remedial math program increased both attendance and achievement over a no report control group (Clarina and Smith, 1989). Knowledge that reports were available affected student behavior in CBI.

Also, CBI instructional systems like the WICAT system utilize the information it maintains on a learner to place or move students in the curricula. For example, if a student misses a certain number of items at a certain percentage score, the WICAT course manager program will automatically set the student back to a lower reading grade level, and in the same way, if the learner is doing exceptionally well, the system will automatically move a student up to a more appropriate grade level. This automatic placement function can be disabled by the teacher, if desired. Additionally, when students are having trouble on a specific topic, the system will lock the keyboard and require the teacher to attend to the student's problem. **CBI systems, then, already make some instructional decisions.**

Correlates with the amount of time spent in a CBI activity, or the general rate expressed as the number of activities completed per minute should be of research interest.

Our interest in this descriptive study centers upon:
1. the relationships between achievement and the rate of completion of CBI lessons,
2. sex and rate of completion,
3. lesson content (math versus reading) and rate of completion, and
4. peer knowledge of progress (classroom wall chart) and rate of completion.

Do higher ability students actually complete lessons more quickly than lower ability students? Is there a difference between the rate at which boys and girls complete lessons? Do students have a characteristic CBI rate regardless of the lesson content, or does a student's CBI rate depend more upon the lesson content? Do classroom wall charts of the number of lessons completed affect students of different abilities differently? Specifically, do such reports cause the lower and slower students to work more rapidly?

**Method**

This pilot study consisted of an intact class of third grade students (n = 27) from a local Catholic elementary school, most of which have had extensive experience with CBI and the WICAT system since the first grade. The CBI lessons were provided by a WICAT S-300 system with 30 student stations. Students spend 30 minutes daily in the computer lab working on various WICAT lessons including reading and math (audio based), writing, language arts, and typing.

Rate data for math and reading were collected from the WICAT report generator over a period of about two months. The rate variable is a decimal value which equals the number of activities completed divided by the total number of minutes on task. The average amount of computer time on-task during the pre-report period of this study in math was 348 minutes and in reading 221 minutes. This information was used for the descriptive relationships related to questions 1, 2, and 3 above. After two months, a simple classroom wall chart was developed and updated weekly. It listed the students' names in alphabetical order and displayed horizontally the number of lessons completed by each student (see Figure 1).

![Figure 1. Classroom Wallchart](image-url)
Students continued working in the lab for about three more weeks. The average amount of time on-task in CBI reading instruction during this report period was 86 minutes. This added information relates to question 4 above, the effect of reports on students’ CBI rate. Achievement data are composite scores from the Iowa Test of Basic Skills (ITBS), form G, taken 10/88 at the beginning of the data collection period.

Achievement and the Rate of Completion of CBI Lessons

Examination of the residuals from a simple regression between ITBS composite scores and reading rate (as activities per minute standard scores) suggested a non-linear relationship. Statworks, a microcomputer statistics package, was used to fit a 2nd order polynomial to the data (see Figure 2).

![Figure 2. Achievement versus Rate in CAI](image)

A significant $r = 0.67$ was obtained. A fairly linear relationship between rate and general achievement exists for students above the 50th percentile however, students below the 50th percentile worked at about the same slow rate, which averaged 1 standard deviation (1 s.d.) below the class average rate.

Sex and Rate of Completion

A significant correlation between reading rate and sex during the first two months obtained as $r = 0.44$ (see Figure 3 below).

![Figure 3. Sex versus Rate in CBI](image)

A slightly higher value ($r = 0.49$) was obtained for the last three weeks during the report condition, suggesting that reports affect both girls and boys similarly.

Since ITBS composite scores were related both to the criterion variable (Rate) and also the predictor variable (Sex), a multiple regression analysis with ITBS composite entering first and Sex entering second indicates that Sex contributed 6.8% of the explained variance with an $R^2$ change from 0.388 to 0.456 which obtained a $t = 1.727$ with a $p = 0.096$, which is a tendency towards significance over and above the effect due to ITBS composite scores.

No interactions between sex and report were noted. Both boys and girls appear to react similarly to the progress wall chart.

Lesson Content and Rate of Completion

A fairly high correlation ($r = 0.81$) between math rate and reading rate was observed (see Figure 4). Even though the WICAT math and reading curricula are very different in nature, it appears that these students' response rates in math and reading were very similar.

Comparisons of reading rate before and with reports also obtained a fairly high correlation ($r = 0.76$). This again implies that students have a characteristic response rate that remains fairly stable. (See Figure 5.)
Peer Knowledge of Progress and Rate of Completion

We assumed that the “good” students were working about as fast as possible, and that the lower ability students were working at a rate that was less than their potential. To some extent, this conclusion is supported by the data displayed in Figure 2 above. We further assumed that our CBI progress wall chart would spur everyone to work harder, but would be especially effective for those students working below their potential.

Correlation between ITBS composite scores and CBI rate with reports (wall chart) obtained a significant $r = 0.48$, which is less than that obtained for the without report (no wall chart) condition discussed above ($r = 0.68$). We interpret this to mean that without the motivation of the progress wall chart, a student’s reading ability is a fairly good indicator of rate of completion of CBI lessons, especially for students above the 50th percentile. However, when reports of progress are made available for peer review, more complex behaviors enter into the relationship.

A multiple correlation of all variables indicated a tendency towards interaction (non-significant) between ability and report, as expected. Figure 6 shows the divergence of the low ability students’ rate with and without reports. Without reports, the low ability students were about 1 s.d. below the class mean while with reports, they approached the class’ average rate.

This interaction tendency is even more clear when the difference (rate with report minus rate without report) is graphed versus reading achievement (see Figure 7). Two horizontal lines are included on Figure 7 at the $+0.5$ s.d. and $-0.5$ s.d. and are labeled “no difference interval.” Points falling above or below this interval represent fairly large differences between students rate with and without class reports. Points falling outside the interval have been darkened for emphasis. Points above this interval represent substantial increases in rate of lesson completion (with wall chart present), while points below this interval represent substantial decreases in rate (with wall chart present). Notice that four “low” ability students (below 50th percentile) have made substantial gains as...
Rate of Activity Completion

The moderately strong relationship between a student's CBI rate and achievement, as well as the strong relationship between a student's CBI rate with different CBI subjects suggests that students exhibit a characteristic rate of responding or way of approaching CBI activities (Schimmel, 1986). This indicates that unobtrusive and instantaneously available rate data may be useful for individualizing instruction.

For example: if a student begins to vary significantly from their characteristic rate pattern and from the average known rate for a particular CBI activity, intelligent software (Lesgold, 1985; Montague, 1982; Schimmel, 1986) may be able to place the student ahead if the rate suggests that the student knows the subject matter or can send the student to remediation options if the rate indicates that the activity is too difficult. Also, CBI rate data may be useful for determining students' national percentile rankings. By using representative national samples with each CBI lesson to determine average scores and rates for each lesson, and then indexing these with recognized national standardized tests like the ITBS, extensive CBI systems like the WICAT system could generate not just class comparison reports but could actually generate reports of a student's statewide or national ranking continuously.

Explaining why third grade boys worked significantly faster than girls is problematic. This may relate to learning style characteristics like risk-taking which tend to be enhanced by extensive association with CBI (Clariana and Smith, 1988). The significant sex factor indicates that regression equations involving CBI rate should be determined separately for boys and girls.

Though reports "speed up" the relative rates of the lower ability students, at least in the short term, we have noticed that the classroom wall chart emphasizes the fact that the slow students are falling farther and farther behind with every weekly update. Though they are working faster than they would have ordinarily, the low ability students are still far slower than the high ability students. They must eventually reach a point of frustration as they see everyone else pull away, even though they are working as hard as possible. This suggests that use of wall charts of progress should be well thought out. If the teacher decides to continue with the practice, then new wall charts should be developed at the beginning of each six weeks period so that everyone starts again at zero each six weeks. Also, slow students may be sent to computer lab for several extra lessons per week. Our previous experience with this practice has shown that the slow students can then catch up and pass the fast students. This has had an overall positive effect on the whole class.
In conclusion, rate data which is easily available in CBI is a much overlooked student variable. Such data may prove to be a potent variable in truly individualizing instruction with interactive systems.

Note: This study was conducted by Dr. Clariana while at Department of Curriculum and Instruction, Memphis State University, Memphis, TN 38152.

References


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