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ABSTRACT

A computer-based interactive video was developed in 1985 for the Texas Learning Technology Group (TLTG) Project, a partnership formed by the Texas Association of School Boards, the National Science Center Foundation, and 12 Texas school districts in response to the national and state crisis in science, math, and technology education. A pilot test of a semester-long high school chemistry curriculum delivered by TLTG was conducted during the 1987-1988 school year, in part to investigate teacher attitudes and teacher implementation behavior. Twenty-six teachers participated in the interactive videodisc (IVD) study, which also made use of records of 2,297 students and achievement data collected from a sample of the students (N = 338). The major findings revealed that IVD students generally achieved higher scores than non-IVD students; IVD students indicated a greater degree of intention to enroll in an elective science course than control students; most teachers liked using the curriculum and found it easier to teach than the traditional curricula; all teachers used supplemental materials in conjunction with the curriculum; and all teachers felt that their students had learned more using the TLTG curriculum than they had learned in previous years. Both videotaped classroom observations of the TLTG curriculum and staff visits to all of the school districts using the curriculum were made during the pilot year. A new evaluation plan has been formulated for the field test year of the TLTG evaluation (1988-1989), and data are being collected on the actual on-site implementation of the TLTG field test curriculum. (4 references) (CGD)

Title:

Teaching Science Using Interactive Videodisc: Results of the Pilot Year Evaluation of the Texas Learning Technology Group Project

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TEACHING SCIENCE USING INTERACTIVE VIDEODISC:

RESULTS OF THE PILOT YEAR EVALUATION OF

THE TEXAS LEARNING TECHNOLOGY GROUP PROJECT

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TEACHING SCIENCE USING INTERACTIVE VIDEODISC:
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Introduction

The new computer-based technologies for delivering instruction are bringing dramatic changes to the classroom. One such technology, interactive videodisc, is being used in the first project of its kind in the nation to deliver an entire full-year physical science curriculum for high school students. The teacher's role in teaching this curriculum, rather than being limited by the technology, has been expanded. Teachers who teach using an interactive technology find themselves managing groups for cooperative learning, for example, in new ways. They become directors of student learning, as well as mentors and guides. They serve as model technology users to their students. They must integrate computer-based lessons into their normal classroom planning. They need not only be familiar with traditional content and methods in their subject area, but must also be adept at orchestrating lessons containing more varied activities which use technology in ways few teachers feel prepared to handle (Savenye & Hudspeth, 1986).

This paper describes the background, methodology and results of an evaluation study conducted during the pilot test of a semester-long high school chemistry curriculum delivered via computer-based interactive video, the Texas Learning Technology Group (TLTG) project. While findings with regard to student achievement and student attitude will be summarized, the primary focus of this paper is on the findings of the qualitative research study conducted to investigate teacher attitudes and teacher implementation behavior.

Overview of the Texas Learning Technology Group Project

Formation

In 1985, the Texas Association of School Boards' Board of Trustees responded to the national and state crisis in science, math and technology education by forming a partnership to produce technology-based solutions to school problems. The Texas Learning Technology Group (TLTG) Project is a partnership among the Texas Association of School Boards, the National

Science Center Foundation, Inc. (NSCF) and twelve Texas school districts. It is a non-profit organization, which has several sources of funding, including NSCF, the districts, and the National Science Foundation.

The goals of TLTG, as described in a recent evaluation report (TLTG, 1989) were to:

- develop high-quality, low-cost curriculum projects that integrate new technologies into curriculum delivery systems,

- evaluate the effectiveness of a technology-based curriculum, and

- train teachers in the use of new technologies and provide support to schools implementing these new, technologically advanced curricula (in press).

After consultation with a curriculum committee consisting of educators from local districts, state educational agencies and universities, TLTG determined that its first course would be a complete physical science curriculum, due to the shortage of science teachers and lack of student motivation in physical science. Other committees were formed to develop content outlines and determine objectives, to provide technical assistance, and to outline teacher training needs.

Development of the Curriculum

Although at first an outside company was contracted to produce the curriculum, TLTG soon determined that quality and cost-effectiveness would best be served by hiring its own development staff to produce the courseware. The staff included managers, instructional designers, computer programmers and graphics specialists, a video and marketing specialist, subject matter experts and, physical science teachers. In addition, design documents, including instructional flowcharts, scripts and storyboards, were reviewed by pilot teachers and national award-winning science teachers, physicists and chemists, and university specialists in educational technology, science education, chemistry and physics.

Teacher Training

In accordance with the goals of TLTG, teacher training was planned from the project's inception. Pilot teachers participated in training sessions from one year before the time the courseware was to enter their classrooms in order to prepare them for the many changes a technology-based curriculum would bring to their teaching. On-going training sessions, for which the teachers may receive college or career-ladder credit, are scheduled for one week in the summer prior to teaching, as well as one day during the fall and the spring semesters.

The training sessions, taught by TLTG staff, experienced pilot teachers and university professors and other specialists, are "intended to make teachers more comfortable with IVD technology and enhance their abilities to incorporate a technology-based curriculum into the classroom" (TLTG, 1989, in press). In addition to learning how to operate and troubleshoot the hardware and courseware, teachers learn how to manage their classrooms using the technology, especially how to design lesson plans, and encourage student interaction with the science materials. During the training sessions, TLTG also solicited teachers' feedback regarding their opinions of the courseware and changes they would like to see made in subsequent versions.

Description of the TLTG Physical Science Curriculum

The TLTG Physical Science curriculum consists of one semester each of chemistry and physics, making up the complete state requirement of 160 hours of coursework. It consists of fifteen instructional units, including an introduction to physical science, seven chemistry units, six physics units and one unit on energy resources. The curriculum integrates computer and videodisc-delivered presentations of information, teacher-delivered demonstrations, simulated labs, computer-based practice exercises, content-based computer games, wet labs, and paper-based practice sets. Included with the videodiscs and computer software is a teacher's guide, which contains objectives, pacing chart, script, summary notes, practice sets, wet labs, suggested demonstrations, and a glossary; a student guide, and unit tests.

The TLTG program is designed to:

o Increase students' in-depth understanding and

rate of learning of physical science concepts and skills,
- Increase the students' interest in science,
- Show the relevance of physical science to daily life,
- Prepare students for an increasingly technological world, and,
- Prepare students for academic and professional advancement in the sciences (TLTG, 1989, in press).

The lessons are different from many computer-based lessons in that they are designed to be used by the teacher with the whole class, or by students working in small groups, rather than by individual students. The curriculum thus relies heavily on the teacher as manager, leader and facilitator. It is not a "stand-alone" computer-based curriculum.

The courseware is designed to run on an IBM InfoWindow touch-screen computer system (with an MS-DOS compatible or PS 2 computer) a videodisc player, and a 25-inch RGB monitor (so that all students in the class can see the screen).

During the 1987-1988 school year TLTG pilot tested the one-semester chemistry course in twelve school districts. During the 1988-1989 school year TLTG is conducting a full-scale field test in over twenty Texas school districts as well as three national sites, in Indiana, Louisiana and Washington State. This paper describes the pilot-year evaluation of the chemistry course, as well as the design of the field-test year evaluation.

Purpose of Formative Evaluation

The TLTG curriculum has been developed using a systematic process of design modified for interactive video. Formative evaluation is one of the primary stages of the systematic process for developing instructional materials and programs (Dick & Carey, 1985). It is conducted to collect data upon which to base decisions during the revision and improvement of instruction. Formative evaluation data is also typically used in designing subsequent programs.

Formative evaluation addresses questions in three major areas: 1) student achievement, 2) student and teacher attitude towards the curriculum and content, and 3) use of the program in actual instructional settings. As the major stage in its formative

evaluation process, TLTG conducted a pilot test during the first year of project implementation.

Pilot Year (1987-88) Evaluation

During the pilot test year there was at least one teacher per district who taught all or most of his or her chemistry classes using the curriculum. In most districts, student achievement data was compared to data from classes which districts had selected to closely match the pilot test classes, but which were using the traditional chemistry curriculum.

The evaluation of the pilot tryout of the chemistry curriculum was conducted by several entities. TLTG contracted with the Educational Productivity Council (EPC), a research group at the University of Texas at Austin, to evaluate the effects of the courseware on student achievement, as well as on certain teacher and student attitudes. TLTG staff members also observed teachers implementing the courseware and solicited teacher critiques of courseware for formative evaluation of units. In addition, university researchers in cooperation with TLTG conducted the study of primary concern in this paper, to measure teacher attitudes towards use of the TLTG courseware and analyze videotaped observations of teacher behaviors exhibited while implementing the curriculum.

Pilot Test Evaluation Goals

Twelve school districts piloted seven units (Introduction to Physical Science, Nature of Matter, Atomic Structure and the Periodic Table, Chemical Bonds, Solutions, Chemical Reactions, and Acid-Base Chemistry) in the Fall semester of the 1987-88 school year.

There were two configurations of the interactive videodisc-based system piloted: seven classrooms had teacher-only configurations, with one workstation and a large monitor for the teacher to use and the whole class to watch; nine classrooms had teacher-group configurations, with five group workstations in addition to the teacher workstation.

Research Questions

The following research questions were investigated:

1. Do students learn more physical science concepts

using the IVD courseware than they do from the classroom instruction it replaces?

2. Do students using the IVD courseware exhibit more positive attitudes toward science and the study of science than non-IVD students?

3. Does the amount of learning differ for students with different levels of verbal and quantitative aptitude?

4. Does the amount of learning differ between each of the two system configurations (teacher-only or teacher-group configuration) and the non-IVD students when students' aptitude levels are taken into account?

5. What are the teachers' perceptions of the TLTG "electronic curriculum" (TLTG, 1989, in press).

Methodology

Data Sources

Twenty-six teachers and 2,560 students in 12 school districts participated in the IVD pilot study. Due to missing student information in some of the student records, 2,297 student records were used in the analysis. Achievement data were also collected on a sample of the students (N = 338) who took physical science from some of the pilot teachers the year prior to the implementation of the pilot program. A sample of control group (non-IVD) students about equal to the number in the IVD pilot study also completed the study instruments.

Teachers administered the achievement and aptitude instruments to the pilot groups during the fall of 1987.

Instruments and Data Analysis

Student aptitude was measured using the Developing Cognitive Abilities Test (DCAT), constructed by Donald L. Beggs and John T. Mouw of Southern Illinois University, administered in September. Quantitative and verbal scores of students were used in the data analysis.

Student achievement was measured by the High-School Subject Tests, Physical Science Test, developed by Scott, Foresman and Company, 1980.

Students' attitudes regarding their intention to enroll in elective science classes, were measured by the High School Science Courses Questionnaire, based on Ajzen's and Fishbein's Theory of Reasoned Action. This questionnaire was administered in May of 1988 to a subset of students from the pilot and control classes in five districts.

Teacher perceptions toward the curriculum were measured using an attitude questionnaire developed for the study and administered during the April, 1988, teacher training session.

Videotaped classroom observations. Several of the pilot teachers were videotaped using the curriculum with their classes, and these videotapes were subjected to microanalysis of the teacher behaviors observed during use.

Results of the Pilot Evaluation

Findings in the areas of student achievement, student attitude toward science and teacher perceptions of the curriculum were reported in detail by TLTG (1989) in its evaluation report and in a report prepared for TLTG by the Educational Productivity Council and will be briefly summarized here.

Findings in the areas of teacher attitudes toward use of the curriculum and preliminary results of the analysis of videotaped classroom observations will be presented in detail in this paper.

Student Achievement

Student achievement data were analyzed by IVD group versus control group, IVD students by quantitative and verbal aptitude, as well as IVD teacher-only configuration with control, and IVD teacher-group configuration with control. These data indicated that, in general, the effects of using the IVD curriculum were positive, however the results were complicated, and varied considerably by teacher and other factors.

In general, IVD students achieved higher scores than non-IVD students. In fact, the average IVD student performed better than 63% of the control students. These differences were not uniform, but were greater for low-ability students, especially low verbal ability, with these students outperforming 68

to 79 percent of the low-ability students in non-IVD classrooms.

The greatest differences in achievement were found between low-ability students in the teacher-group configuration and low-ability students in the non-IVD classroom.

Student Attitudes

IVD students indicated a greater degree of intention to enroll in and elective science course than control students. Of particular interest is the finding that of students who had previously failed a science course, those in the IVD group indicated a greater intention to enroll in science than their counterparts in the control group (EPC, 1988; TLTG, 1989).

Teacher Attitudes

Teacher perceptions of curriculum. Nineteen of the twenty-five teachers completed an "implementation and use" questionnaire during the spring teacher training session in April, 1988. All of the teachers indicated that they liked using the curriculum, with 14 agreeing strongly with the statement, and five agreeing.

Fourteen of the teachers indicated that it was easier to teach using the IVD curriculum than it was to use their traditional curricula.

All of the teachers indicated that they used supplemental materials, such as their own activities and worksheets, in conjunction with the curriculum. Six of the teachers said they used other materials 10% of the time, five teachers said they did so 20% of the time, three 30% of the time, one 40% of the time, 2 50% of the time, and 1 60% of the time. Some of the teachers indicated that they did not use some parts of the TLTG curriculum. For example, six teachers said they did not use some of the wet labs, while four teachers said they did not use some practice sets.

All the teachers felt that their students had learned more using the TLTG curriculum than they had learned in previous years. The reasons they gave for this included: the TLTG curriculum provided more opportunities for participation and interaction, the material was more stimulating and interesting to students, teachers saw more enjoyment and willingness

to work on the part of the students, and the information was provided in a variety of formats.

All but one of the teachers indicated that their students liked learning chemistry by using the TLTG curriculum, stating as reasons, for example, that students know they've learned more than non-IVD students, that the visuals helped them understand concepts, that they could participate more, that it was different, and that it stimulated students' interest.

With regard to what students liked the best, most (15 of 19) teachers stated that the students liked the computer and videodisc-based games and simulations best. Teachers also mentioned that students liked the small-group activities, the teacher-pupil relationship, the visual stimulation, the electronic instruction (2), the immediate feedback, sound effects, particular units and topics, and practical applications of the content.

With regard to the major differences for the <u>teacher</u> in using the curriculum, teachers mentioned a greater workload during this first year (10 of 19), more positive interactions with students (7), that it made teaching less stressful, some said it required more preparation time while others said less, students learned to help each other, and that it made the teacher more of a manager.

<u>Analysis of Videotaped Classroom Observations and Staff Visits to all School Districts</u>

During the pilot year, five teachers were videotaped conducting their classes using the TLTG curriculum. Preliminary microanalysis has focused upon the behaviors of a sample of fifteen minutes each of the classes of two of these teachers. These teachers were selected because they were both using the courseware with a whole-class for the full hour of class. The other teachers were using the courseware for only a few minutes or were using the systems to do small-group labs. Follow-up analyses are planned with the other classes, focussing upon student behaviors.

When using the teacher-led portion of the curriculum, teachers can comment or ask questions about the content presented when the system pauses on a frame. These pauses occur at regular intervals (approximately every 30-40 seconds) and are often accompanied by a text definition or question.

T-achers can also control system pauses by touching a "STOP" icon on the screen. Teacher behavior during a program or teacher-initiated pause was coded for analysis. Pauses are initially coded as to whether they are teacher or program-initiated. Some examples of codes include the following:

Teacher Statements:

- EX - Teacher extends the information presented by the TLTG system to new information
- PA - Teacher paraphrases the information presented by the system in own words
- D - Teacher directs the student to do some action (for example, to take out a piece of notepaper, or to write down a vocabulary word)
- EM - Teacher emphasizes key information presented by the system, by cueing the students, for example, by telling them to notice some key attribute of a concept.
- DES - Teacher simply desribes what is on the screen

Teacher-Initiated Questions of Students:

(Coded first by whether they are asked of whole class or of an individual student)

- REC - Teacher asks students to simply recall information just presented by system
- S.Ex - Teacher asks students to tell their own examples of the information just presented, i.e. examples relevant to their own lives
- EX - Teacher asks students a question which extends the information presented to new concepts, information or examples
- HOW - Teacher asks students how a phenomenon or process presented by the system occurs
- WHY - Teacher asks students to explain why a phenomenon or process occurs

Feedback to Student Responses to Teacher-Initiated Questions:

(several types can be combined)

- KR - "Knowledge or Results Feedback" - Teacher tells students whether their response is right or wrong
- KCR - "Knowledge of Correct Results" - Teacher tells students the correct answer
- I - Teacher provides information in the feedback

Student-Initiated Comments and Questions:

- QU - Student asks teacher a question (oft answered by the teacher in the form o. another question and then feedback to student's answer)
- COM - Student comments on something teacher said
- ANS - Student answers the teacher's question

Based on teacher observations and a preliminary analysis of data, teachers, as a rule, made statements about the content or asked questions when the system paused. Teachers rarely used the stop icon to stop the program themselves, and when they did, it was usually done to repeat a video special effect, rather than to clarify a point.

When commenting, teachers generally paraphrased what was just presented, emphasized main points, and extended the information. When asking questions, teachers usually asked students to recall what was just covered, remember prior information, and apply the knowledge to new situations. When an answer was posed by the system, teachers repeated the question and then evaluated the student answers. Since an answer screen usually followed a question screen and sometimes included feedback in response to an input, students were often getting feedback twice.

There appear to be two types of teaching styles, one that concentrates on dispensing information and one that focuses on seeking information from the students. Teachers who are dispensers of information spend the majority of class time clarifying, paraphrasing, or extending the information provided by the courseware. They do not ask many questions and, in some cases, do not even solicit answers from questions posed by the system, preferring, instead, to answer the questions themselves or tell students that they will find out the answer. Teachers who are seekers of information spend much of the class time asking students to recall what they've just seen and heard, to apply that information to different examples, or to make inferences about a situation by connecting the new information to prior knowledge. These teachers also comment on the material, so much information is exchanged between teacher and students.

Plan for the Field Test Year (1988-89) Evaluation

A new evaluation plan was formulated for the field test year of the TLTG evaluation (1988-1989). A

team consisting of TLTG staff members and university researchers involved are collecting data regarding student achievement on objectives-based and standardized achievement tests, and regarding student intention to enroll in science courses in the future. This electronic curriculum, however, relies heavily on teacher management, integration, and delivery. Since it is not a "stand-alone" individual-instruction curriculum, actual classroom implementation data are critical in order to evaluate the real effects of the interactive videodisc science curriculum.

Implementation Study

Data regarding the actual on-site implementation of the TLTG field test curriculum are being collected to answer the following major questions: How are the students and teachers using the curriculum and how do they feel about using the curriculum? More detailed questions include:

1) What are the student and teacher attitudes towards specific instructional design aspects of the electronic curriculum? For example:

   Students - What do students like and dislike about the curriculum? What do students feel helps them the most? What do they feel confuses them? What makes this curriculum unique to them?

   Teachers - What do teachers like and dislike about the curriculum? What do they feel helps students learn the most? How do they feel teachers should be trained to use this type of electronic curriculum? What do they want to learn now about using it? How do teachers believe their classroom role are changing?

2) How are the teachers actually implementing the electronic curriculum in their classrooms? For example,

   What do teachers do as they use the curriculum with whole classes, with small groups and in incorporating the curriculum with wet labs? What do teachers use and not use in the curriculum, and what do they add to it?

   Other questions related to teacher behaviors include:

   A) - What content are the various "electronic delivery" and "control group" teachers

teaching? Does the content differ between or within groups? If so, how?

B) - What activities built into the curriculum do teachers use? How do these differ between the teachers who are using the teacher-only workstation for presentation of instruction, and those who have several small-group workstations? How do the teachers in these two configurations handle the wet labs and simulated labs, as well as computer and teacher-delivered practice?

The implementation and attitude data are being collected using several methods: videotaped classroom observations, and student and teacher questionnaires and interviews. To summarize:

Data sources -	Teachers in all thirty selected "experimental" field test classrooms, students in a sample of about six of these classrooms (approximately 180 students).
Instruments -	Student and teacher questionnaires; interview protocols for teachers and students; analysis protocols for videotaped observations.
Procedures -	Administration of student and teacher questionnaires at the end of each semester; teacher and student interviews using established protocols; videotaped observations conducted in sample of classrooms throughout the field test year.

Discussion/Recommendations

This physical science curriculum is unique in the nation. It is the only full-year science curriculum to be delivered by the teacher using interactive videodisc technology in both whole class and small group configurations. This paper described the methodology and results of the pilot evaluation of the TLTG curriculum, conducted during the 1987-1988 school year with over 2000 students and twenty-five teachers in twelve school districts in Texas. The plan for the field test evaluation, being conducted during the 1988-1989 school year with over five thousand students

and thirty teachers in four states, was also described.

The effectiveness of the interactive videodisc-based curriculum in teaching chemistry to high school students was demonstrated. Evaluation results indicated that students who used the TLTG curriculum generally learned more than students in control-group classes who learned chemistry using traditional methods, as measured by a standardized science achievement test. It was noted, however that results were not consistent for students of varied verbal and quantitative abilities. Both the achievement data and the teachers' perceptions indicated that the IVD curriculum seems to be more effective with low-ability students.

Achievement varied considerably by teachers. Questionnaire data and preliminary analysis of videotaped classroom observations indicate that the teachers' implement the curriculum very differently. For example, two basic teaching styles appear to be used with the curriculum. Some teachers seem to simply add information to the TLTG presentations during the "pauses", while other teachers seem to use these pauses to ask students questions, provide them with feedback, solicit student-oriented examples of phenomena learned about, and initiate discussions. It is hoped that during the field test year, the qualititive study will yield data regarding teacher behaviors that are most effective when using a teacher-managed electronic curriculum, such as this one.

The pilot evaluation results indicate that teachers have positive attitudes about using the TLTG videodisc-based curriculum, and that they feel their students are learning more, and like learning better, when using the electronic curriculum. Teachers indicated that using the curriculum has changed the behaviors they engage in, as well as their role in the classroom. They also indicate that students particularly enjoy the interactive, visual-based nature of the curriculum, especially the games and simulations.

Feedback from the teachers was a key factor in revising the design of the TLTG courseware. Teachers indicated that they want the technology to be as transparent as possible, so they can concentrate on the content, rather than the technology. To this end, several features have been designed into the program.

One feature is a user program, which allows teachers to load, run, and erase software and diagnose technical problems via a menu. This program permits teachers to use the system without having to know DOS structure or commands.

Another feature is a menu system which promotes smooth navigation through the courseware and easy access to lessons or practice activities. The main menu titles are related to topics, with each topic branching to submenu titles tied to objectives. Since teachers may not get through a whole lesson in a period or may want to review parts of a lesson, a user control feature was designed to allow teachers to skip ahead in small chunks. To let teachers know where they are in the system, they are told which section was just completed and what section is next. They can continue or go to the main menu.

In response to teachers' request that the program pause often to allow them to reinforce points or check for comprehension, the system is programmed to pause at regular short intervals, such as when a new concept or term is introduced. Text statements or questions are provided whenever the program pauses to cue teachers about what should be discussed or to allow students to take notes about the information. Since student attention was observed to fade after about two minutes of linear video, the video sequence rarely runs for more than a minute.

Because teachers are evaluated on how often they provide constructive feedback to students, they preferred to inform students about the correctness of their responses, rather than the system. Consequently, the teacher-led portion of the curriculum, with the exception of the teacher-led practice activities, does not include many places where an answer is entered and, therefore, evaluated. However, each question screen is followed by an answer screen.

The pilot year evaluation of the TLTG curriculum has several implications for teacher training for classroom use of technology. Since teachers have a great need to become comfortable with the technology as quickly as possible, it is recommended that they have a lot of hands-on time with the IVD system. TLTG hands-on sessions during teacher training, for example, now include experiences with using the videodisc player, loading and running the software,

breaking down and setting up the equipment, previewing the IVD instruction, and planning lessons.

To demonstrate the adaptability of the system to different teaching styles, it is advisable to show different teachers teaching with the system. TLTG, for example, invites experienced teachers to show new project teachers how they teach using the curriculum. If it can be shown that certain teaching styles are more effective than others, recommendations can be made to teachers about what works when teaching with the courseware.

Since preliminary reports indicate that the IVD system works well with students that have learning problems, teachers should be given information about how they can use the courseware effectively with this target population.

Finally, it is recommended that in evaluations of videodisc-based curriculum, plans be made to include multiple sources of data collected over a period of several years. The TLTG curriculum is unique not only in its design and goals, but in the scope of the field test currently being conducted. Results of the field test will not only be useful in designing computer-assisted interactive video for science instruction, but for developing recommendations for implementing other interactive video curricula in the schools.

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