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ABSTRACT

Computer-assisted instructional programs have been developed at the State University College at Potsdam, New York, to teach basic concepts of music theory. The Computer-based Learning Experiences in Music Fundamentals (CLEF) project has spawned computer assisted instruction (CAI) programs which use an IBM 360/30 configuration with 2741 terminals and the Coursewriter, BASIC, and APL languages. CLEF is intended for students at all levels of proficiency and provides an opportunity for flexible, self-directed study. These CAI programs in music theory, fundamentals, and Greek theory are collateral to coursework, are usually recommended rather than required, are available to all students, and are organized to permit the student to take what he wants when he desires it. Future developments may permit CAI programs to teach harmonization, voice leading, cadence formulae, and compositional concepts; in addition, scores may be displayed, problem solving will be possible with APL, and electronic music can be studied using a FORTRAN-based program. To maximize CAI contributions, however, it will be necessary to overcome the assumptions that CAI must be programed instruction (which, additionally, is "friendly" to students), and that the computer is going to replace the teacher. (PB)

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CAI IN MUSIC THEORY: PARADIGMS: POTENTIAL: PROBLEMS

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The computer, an accepted and essential ancillary component of everyday operational procedures for business, industry, many professions and most branches of the sciences, has emerged as an extremely useful pedagogical tool. For the past several years, experiments exploring computer usage as part of the instructional process have been conducted; the computer's potential as a participant in the teaching or presentation of certain aspects of music instruction, particularly theoretical concepts, only recently has been examined to any extent.

A very important goal in the preparation of computer-assisted instructional programs in music theory is the development of a network of basic theoretical concepts within the mind of the student. The content of the programs is determined by the basic need of music students to acquire a mental bank of fundamental data that can be used in a variety of applications. The development and implementation of programs that utilize the computer's inherent capabilities provide challenging opportunities for students and instructors.

Since 1967, computer-assisted instructional programs in music theory have been developed at the State University College, Potsdam, New York. The branching and strand organization of the programs developed under Project CLEF (Computer-based Learning Experiences in Music Fundamentals) constitutes a curricular grid that offers maximum flexibility in usage. The varied educational environment at the College provides an ideal opportunity to test the programs as they develop. The positive responses and constructive suggestions from over six hundred students who have experienced various segments of the available programs have contributed to program development and have demonstrated the validity of computer usage in the teaching of music.

The programs primarily are designed for collateral and supplementary use with Music Theory or Comprehensive Musicianship courses. They have been prepared through collaboration of the Crane School of Music (Ralph J. Wakefield, Dean) and the Computer Science Department (Alan R. Stillman, Director).

Initially, hardware included an IBM 1401 configuration and 1050 terminals. Since 1969 an IBM 360/30 configuration with 2741 terminals or 2260 CRT's has been in use. The principal programming language is Coursewriter (modified versions of II and III); some work has been prepared in BASIC, and currently, consideration is being given to APL.

Musicianship, innate or to whatever extent developed, is not dependent solely on an understanding of music theory. It is impossible to become a complete musician, however, without possessing a thorough knowledge of the materials and structure of music. The study of the theoretical concept of music must always parallel and be related to study in music history, applied music and performance. Music theory must never become a rigid discipline, so academic that it is a separate study, an entity unrelated to other aspects of musical endeavor, or even, perhaps, to music itself.

The primary function of the computer as a participant in music instructional processes is to provide maximum opportunity for self-directed study of parametrically delineated concepts and materials. Intended for use by students at any level of proficiency, program segments considered most appropriate may readily be selected for study or review.

Because of its inherent capabilities, the computer has the potential to provide a pedagogical thrust of its own. Unlike any other instructional aid, it can offer a variety of programming capabilities, ranging from the most simple linear sequences to extremely complex problem-solving and simulation programs.

A very important facet of Project CLEF is the opportunity available to test the developing programs in a varied curricular and educational environment that involves many different types and levels of students. At Potsdam, "Research, Development, Implementation and Testing," have never been linked to the particular content of specified courses and have always benefited from the experiences and comments from large numbers of students.

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The student enrollment at the Crane School of Music, State University College at Potsdam, currently (1972-73) is approximately six hundred majors, including undergraduate and graduate students in a variety of concentrations. Typically, about half of these are enrolled in Music Theory or Comprehensive Musicianship courses, usually taken during the freshman and sophomore years. The total student body of the College includes approximately 4,300 students representing a wide diversification of interests and needs. Many liberal arts majors, outside music, elect music courses as part of their academic requirements. The computer-assisted instructional programs are available to all students on a sign-up basis. During any given semester, approximately one-third of the music majors and many other students experience various segments of the programs available. Additionally, the programs are available to in-service area teachers, many of whom are enrolled in graduate courses.

Paradigms

The paradigmatic organization of the CAI programs developed under Project CLEF reflects the basic philosophies of the authors.

1. The programs enhance and are collateral to coursework; they do not replace or represent any particular course.
2. The programs are seldom required; they are frequently recommended.
3. The programs are available on a sign-up basis to all students.
4. The strand organization of the programs allows the student to take all or any portion of the programs available; segments may be taken in any order, or repeated as often as desired.

Programs currently in use

1. Music Theory I: 14 units on Music Fundamentals. Dialogue, action response format; branching and strand organization; accompanying explanatory manual. Units include sections on Intervals, Clefs, Trichords, Tetrachords, Scales, Modes, Signatures, Transposition.
2. Music Theory II: 10 units. Multiple choice, recognition format, strand organization; accompanying reference manual containing material related to questions. Units include sections on Scale and Chord patterns and structures, Signatures, Counterpoint, Harmonization, Analytical problems.
3. MUSICFUN: 10 units on Music Fundamentals. Dialogue, short answer action response format; branching and strand organization. Program is designed primarily for students with limited background. Questions are randomly selected by computer from "question banks" related to each concept. Units include sections on Intervals, Tetrachords, Scales, Chords (various types), Harmonization, Chord Progressions.
4. Greek Theory: Program is designed as a study review of ancient Greek musical theoretical concepts. Information retrieval and questions are in random access format. The student may choose to have information only, information and related questions (for example, definitions, and applications), or questions only.

Programs under development

The addition of sound capability (interfaced organ, synthesizer, or other sound generation unit), planned for the near future, offers opportunity for the development of dictation and identification exercises, error recognition, melodic movement, and certain problem-solving functions. A few examples follow:

1. In an accompanying manual, or preferably through a visual display, the student is presented with a pattern such as:

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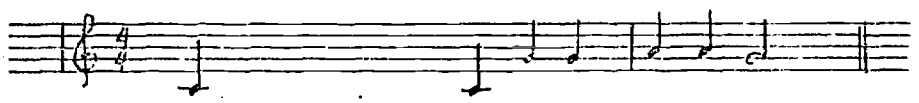
The computer "plays" the first three pitches, plus one or two more. The student then identifies the additional pitches by typing letter names or by pointing to their position on the screen with a light pen (depending on hardware capability).

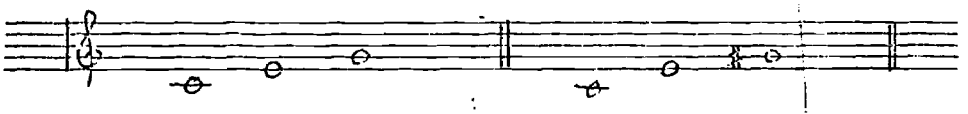
2. In a manner similar to the above, the student is told the name of the first pitch, then several more are played--all of which he then identifies in order.

Identified by computer Identified by student



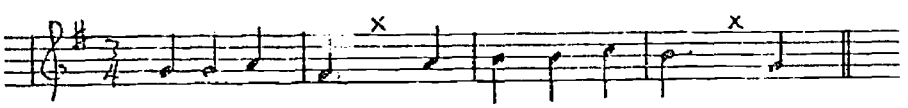
3. A chord is presented in the manual (or on the screen) which differs from the one that is played. The "chord" may be played as a vertical simultaneity or as an arpeggio.

Written or displayed Played

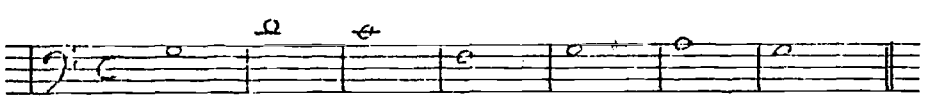


The student then identifies the "incorrect" note.

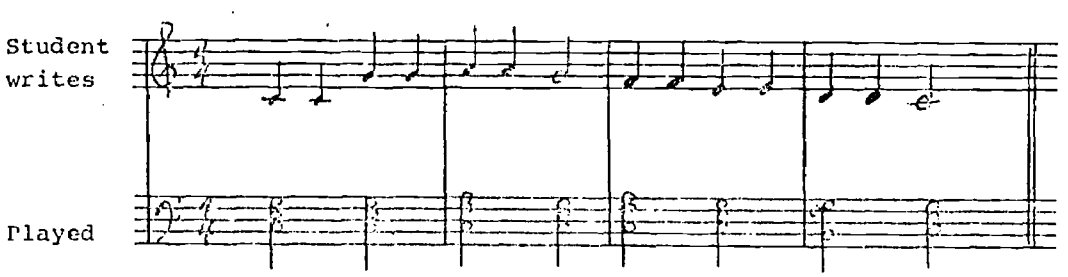
4. A melody is presented on the screen with certain notes marked "x". The melody is then played completely. The student indicates the names of the missing pitches.



5. A cantus firmus is presented in the manual or on the screen. The student is asked to write a counterpoint to the cantus firmus, following rules discussed in class.



6. A chord progression is presented, over which the student writes a melody.



In each case, an incorrect designation or response by the student would be identified and "commented upon" by the computer. A correct response would receive an "O.K." or similar statement from the machine; the program would then go on to the next question.

Potential

As more sophisticated equipment (hardware and software) becomes available at reasonable cost, program planning becomes more challenging, more flexible, and much more adaptable to the needs of individual students. The highly developed state of the technological art today offers an array of possibilities; for practical purposes, however, only a few of these are

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presently available. Of these many developments, for the hopefully fairly near future the following are of particular interest:

1. The development of a two-way organ (or other keyboard instrument) interface for teaching harmonizations, voice leading, cadence formulae. The student may thus "play back" his responses.

2. The graphic tablet (hand tablet) with a dictionary of machine recognizable hand generated symbols (alphanumeric and musical), useful for teaching compositional concepts in various styles.

3. An interfaced computer-managed microfiche reader (random access of particular frames is easier than with microfilm), useful for displaying scores and other musical segments.

4. The problem-solving capability of APL type languages offers an additional dimension to the teaching of musical concepts.

5. The capabilities of the FORTRAN-based Music V program (developed at Bell Laboratories and recently modified as Music 10 at Stanford University) offer additional resources for the purposes of teaching musical concepts and the study of certain aspects of electronic music.

The computer has proved its validity as a participant in the pedagogical process. The real potential of CAI lies in the direction of heuristic possibilities - flexible, individualized, guided instruction--and away from the concept of automated programmed instruction linked to a course by course lock-step curriculum.

Problems

Educationally speaking, we are in a period characterized by changing attitudes, challenges to established methods and procedures, and constant transition. Our continued effort must be to try to improve the instructional process for all concerned--not just look for new ways to present the old material better (faster?).

Unfortunately, CAI development has been hampered by certain initial and somewhat still persistent misunderstandings and misconceptions: a) that CAI must be a kind of programmed instruction; b) that the computer must seem "friendly" to students (hence, the inclusion of "friendly, encouraging comments" in many programs); c) that the computer is going to replace the teacher. Instructional segments may and do involve "programming"; the best instruction, however, is not "programmed". It has been amply demonstrated at Potsdam that students come to the terminal to study and the less dialogue used in the program the better. Obviously, the computer is not replacing anyone; certain tasks may change, however, and others may develop, as in any business as time goes on. Hopefully, these misconceptions are being clarified. The biggest and perhaps only problem is to determine the best ways to utilize the capabilities of the computer in an ever-changing educational environment.

Needed at present are time and support: time to develop the team--author, programmers, and technicians to write, de-bug, implement and test programs; support (administrative and financial) to provide programming competence plus some dollars for hardware and software. At this point it would seem that large amounts of money are unnecessary; smaller amounts are needed to enable the team to plan and work together to optimally utilize presently available equipment--adapting and modifying as necessary for musical applications.

Conclusion

Of the existing technologies available, only the computer can approach the accomplishment of most of the instructional needs that have always been met to some degree and in one way or another by the teacher in the classroom. As many basic instructional needs are met by technology, teachers become more free than ever before to conceptualize and interrelate with students the many facets of any particular discipline. As a participant in the instructional process, the computer demonstrates the capability of offering a cybernetic rather than rigidly programmed approach.

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