

Guided Discovery Tutoring and Schoenberg's Harmony Teaching Method: an Investigation

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***Abstract.** This paper describes a computer-based learning environment presenting the pedagogy and part of the curriculum of Schoenberg's harmonic teaching method. The pedagogical constraints which guided the design and construction of the environment are presented and compared with the constraints found in traditional harmony teaching.*

Results from studies involving the prototype learning environment are presented: a formative evaluation was carried out with music experts with the aim of assessing its interactive music notation interface and to inform changes and improvements to be made to the prototype; and a summative evaluation was conducted with music lecturers to assess not only the degree of faithfulness of the environment to the method, but also the educational benefits that such an environment can potentially bring to harmony teaching. The results of the studies suggest that materials of the method can be delivered, and can be made accessible to the user, by a computer-based environment embodying a computer model of Schoenberg's method of teaching harmony.

1. Introduction

Most traditional musical harmony teaching methods in use in undergraduate courses are centred on pedagogical principles that require students to manipulate musical elements, beyond those directly relevant to the subject matter. Beginning harmony students often encounter extra difficulty in the learning process as they usually lack experience in manipulating individual musical elements. In addition, the emphasis on exemplars of the common practice of eighteenth and nineteenth century composers imposes some limitation on the student's harmonic vocabulary and, in consequence, on the student's creativity.

At the beginning of the twentieth century, Arnold Schoenberg proposed a method of teaching harmony [Schoenberg, 1990] which presented a different set of pedagogical principles: the method required no background knowledge of other musical elements; it encouraged the exploration of the search space of solutions which, in conjunction with a self assessment of them, helps students to develop their own harmonic sense, without the influence of exemplars of the harmonic practice of existing composers. However, although Schoenberg's method addresses the problems presented above, it has not been widely used, mostly because its fundamental pedagogy and curriculum are buried in lengthy philosophical discussions of polemical arguments and criticism of traditional methods.

This paper investigates the possibility of designing and constructing a computer-based learning environment presenting the pedagogy and curriculum of Schoenberg's harmonic teaching method while remaining true to its spirit. We present a formalisation of part of the method's curriculum and associated pedagogical principles which have been embodied in a prototype learning environment. The results from studies involving the prototype are also presented: a formative evaluation was carried out with music experts aiming to assess its interactive music notation human computer interface and to inform changes and improvements to be made to the prototype; and a summative evaluation was conducted with music lecturers to assess the degree of faithfulness of the environment to the method.

The outcome of this research demonstrates that rules and pedagogical principles from Schoenberg's harmonic teaching method can be formalised and are amenable to modelling on a computer. The results of the studies presented here suggest that materials of the method can be delivered, and can be made accessible to the user, by a computer-based environment embodying the computer model introduced above.

2. Traditional Harmony Teaching Methods

Traditional harmony teaching methods are centred on the four-part harmonisation of given melodies [Piston, 1978, Rockstro, 1881, Gauldin, 1997]. The student is required to construct horizontally independent voices that fit into a melody line. The melody examples try to illustrate the so called harmonic common practice of composers of the eighteenth and nineteenth centuries. Figure 1 assumes homophonic harmonisation using major chords I, IV and V as a simplification and illustrates the main steps, described below, that students are usually advised to follow when harmonising melodies.

Step 1: List all chord choices

All chords that can be associated with each note must be made explicit as Roman numerals. Figure 1(a) shows the 32 possible degree sequences for the melody.

Step 2: Refine chord choices

Tonal music pieces almost always start and end at the same tonic chord (chord I). If different start and end chords are eliminated from Figure 1(a) there are still 8 alternative degree sequences remaining, as shown in Figure 1(b).

Step 3: Further refine choices

Musical background knowledge is now required to select a musically meaningful chord sequence from the remaining alternatives. Figure 1(c) shows the chord sequence likely to be chosen by an experienced composer as it contains the largest repeated pattern (of length 3).

Step 4: Define a bass melody

A number of constraints must be simultaneously satisfied: chord sequence, voice range, preferred opposite movement for the soprano and bass voices, provide room for internal voices are amongst them. Figure 1(d) shows a choice that satisfies the mentioned constraints.

Step 5: Define the remaining voices

Again a number of constraints must be simultaneously satisfied: chord sequence, voice range, avoid crossing of voices, avoid parallel octaves and parallel fifths are amongst them. Figure 1(e) shows a possible assignment for the internal voices.

(a) List chord choices

(b) Refine choices

(c) Further refine

(d) Define bass line

(e) Define remaining voices

Figure 1: Harmonising a melody

The pedagogical constraints of traditional harmony teaching methods are associated to a number of difficulties experienced by beginners:

(a) Background Knowledge

Exercises require students to have considerable background knowledge of other musical elements such as rhythm, counterpoint and form, which adds complexity to the learning process;

(b) Harmonic Analysis of Melodies (Assigning degrees)

Harmonic analysis is the process of assigning degrees to parts of a score. If the score is a single melody, it can accommodate alternative harmonic sequences (as in Figure 1(a)), and the selection of the “best” alternative that suits it is the ultimate goal of the analysis process (Figure 1(c)). However, beginners usually do not have enough experience for the task, and do not understand what “best” means in this context. So there is a tendency for the teacher to impose on students “acceptable” harmonic sequences which are incorporated into the student’s harmonic vocabulary;

(c) Harmonising a melody (Assigning Notes to Voices)

Having assigned degrees to the melody, notes must be allocated to the remaining voices according to the harmonic analysis (see steps 4 and 5 in Figure 1(d) and 1(e) respectively). However, depending on how adequate the harmonic analysis is, it may be difficult, or even impossible, to allocate notes to the voices without violating some of the various musical constraints;

(d) Teacher-centred Approach

In traditional methods the teacher usually gives lectures [Peters and Miller, 1982] to a group of students, in which excerpts of musical pieces are harmonically analysed, exercises are proposed and some of the student's solutions are corrected;

(e) Large corpus of tonal pieces

Traditional methods require a large heterogeneous corpus of excerpts of tonal musical pieces such as sonatas, concertos, and even folk songs to illustrate particular harmonic practices.

3. Schoenberg's Harmony Teaching Method

Given the difficulties experienced by beginners who are taught with traditional harmony teaching methods, are there alternative methods that address them in a consistent way? More specifically, is there a harmony teaching method that satisfies the following constraints?

- (A) Assume less background knowledge, and try to isolate the other elements of music (rhythm, counterpoint and form) from the harmony teaching;
- (B) Guide the student in selecting degrees in exercises that do not require harmonic analysis;
- (C) Avoid harmonising a melody in order to give students more alternatives in assigning notes to the voices;
- (D) Provide a more student-centred approach to teaching in order to maximise the student's creativity;
- (E) Avoid a large corpus of tonal pieces.

There are some alternative harmony teaching methods which follow some of the above principles. For example, there are a number of methods which emphasise technically correct connection of chords without paying too much attention to the other elements of music (constraint (A) above). Hugo Riemann centred his harmony teaching method around this premise [Riemann, 1895], and he aimed to produce a scientific theory of musical hearing centred around chord progressions involving only three kinds of tonal functions – tonic, subdominant and dominant. However, the emphasis given to these three functions makes it incompatible with constraints (B) and (D) above.

Schoenberg's harmony teaching method [Schoenberg, 1990] is also centred around technically correct connection of chords. However, he was more concerned in avoiding imposing "acceptable" progressions on students and in giving them more freedom of choice. Schoenberg believed that students, through experimenting with not only "acceptable" chord progressions and assessing their aesthetics by themselves, are capable of fostering their own harmonic sense without the strong bias of the harmonic vocabulary imposed by traditional methods. Schoenberg's method is distinguished by a curriculum that does not involve harmonisation of melodies and that incorporates a carefully designed incremental strategy of presentation and practice of new concepts. Figure 2 illustrates the main steps, described below, followed by students in the proposed exercises.

Step 1: Chord sequence definition

The student, guided by instructions, selects the degree sequence to work with.

Figure 2 consists of six musical diagrams, labeled (a) through (f), arranged in a 3x2 grid. Each diagram shows a grand staff (treble and bass clefs) with a sequence of five chords: C: I, IV, ii, V, I. The diagrams illustrate the step-by-step construction of the notes for each chord, with fingerings indicated by numbers 1-4. Diagram (a) shows the first chord (I) with no notes. Diagram (b) shows the first chord with notes C4, E4, G4 in the treble and C3, E3, G3 in the bass. Diagram (c) shows the second chord (IV) with notes F4, A4, C5 in the treble and F3, A3, C4 in the bass. Diagram (d) shows the third chord (ii) with notes D4, F4, A4 in the treble and D3, F3, A3 in the bass. Diagram (e) shows the fourth chord (V) with notes G4, B4, D5 in the treble and G3, B3, D4 in the bass. Diagram (f) shows the final chord (I) with notes C4, E4, G4 in the treble and C3, E3, G3 in the bass. The diagrams show the progression from an empty staff to a fully constructed sequence of chords.

C: I IV ii V I
(a) Step 1

C: I IV ii V I
(b) Step 2

C: I IV ii V I
(c) Step 3

C: I IV ii V I
(d) Step 4

C: I IV ii V I
(e) Step 4

C: I IV ii V I
(f) Step 4

Figure 2: Steps into the solution to an exercise

Step 2: Note assignment for chord 1

The student decides the position of the initial chord and assigns notes to the voices while observing chord construction constraints.

Step 3: Note assignment for the next chord

The student assigns notes to the chord immediately to the right of the last constructed chord, observing simultaneously the chord construction constraints and the chord connection constraints imposed by the assignment of notes to the previous chords.

Step 4: Repeat Step 3 to all remaining chords

Students repeat step 3 until notes are assigned to all chords of the sequence.

Schoenberg presented, late in his life, a condensed form of his method of teaching tonal harmony [Schoenberg, 1989]. This book presents also his final thoughts on tonal harmony, such as his charts of key distance showing how closely or remotely related a key is in respect to a central key. These charts are in close accord with the findings from [Krumhansl and Kessler, 1982] in respect of empirical judgements of chord-relatedness. The matching of empirical results with the theoretical principles underlying Schoenberg's method, highlighted in [Krumhansl, 1990, pp 46-49], suggests a strong cognitive plausibility of the method, and gives support to the research described in this paper.

4. The Prototype Learning Environment

Schoenberg's harmony teaching method is based on an exploration of the harmonic possibilities of chord connections under the guidance of a tutor, who is in charge of supervising

ing the sequencing of material according to the achievements of the student. This way of teaching seems to be particularly suitable for modelling under the Guided Discovery Tutoring framework [Elsom-Cook, 1990], in which the internal representation of the domain is as important as the external representation at the interface.

The architecture of the prototype Schoenberg's style harmony learning environment is based on the model that has been used in the development of Intelligent Tutoring Systems [Burns et al., 1991]. The high level components of the environment are shown in Figure 3 .

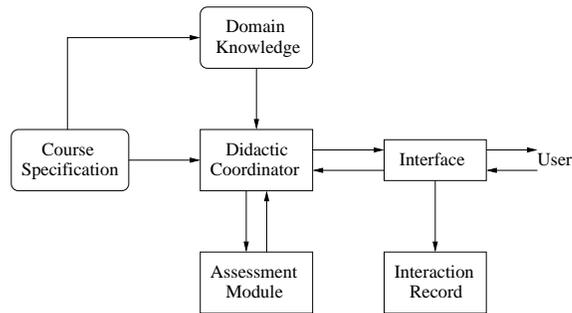


Figure 3: The architecture of the learning environment

The interaction screen, shown in Figure 4, contains a musical canvas that allows vertical insertion or deletion of notes, buttons to access features of the system, and text areas for instructions and feedback. Chords can be constructed using the mouse, one at a time, from left to right: the student is allowed to move to the next chord only when the focused (current) chord and its connection to the previous one is considered correct.

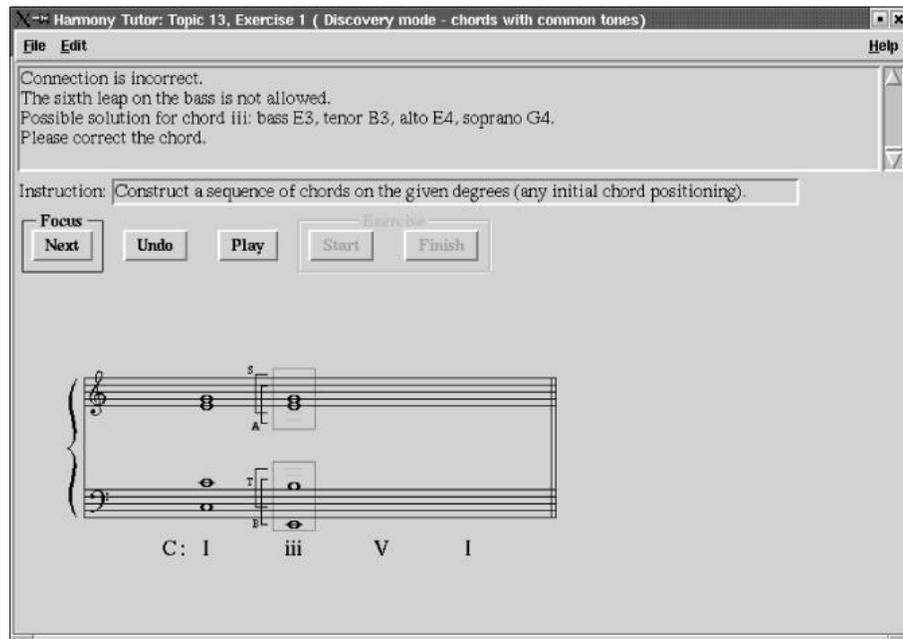


Figure 4: The interface window

5. The Evaluation Studies

The evaluation of the prototype learning environment above was conducted in two phases: the formative and the summative evaluation. In both evaluation studies the participants were invited to interact with the system, performing specific tasks, after what a semi-structured interview were conducted (see [Brandão, 2002] for details).

Formative evaluation

Aimed to evaluate the human-computer interface and to obtain information to be used to modify and improve the system operation. The evaluation was carried out by three music teachers with expertise in tonal harmony teaching, although their musical interests and specific expertise varied widely. All actions from the evaluators were recorded and reproduced later as action diagrams (see Figure 5) which, together with information collected on a semi-structured interview, informed the modifications made on the system;

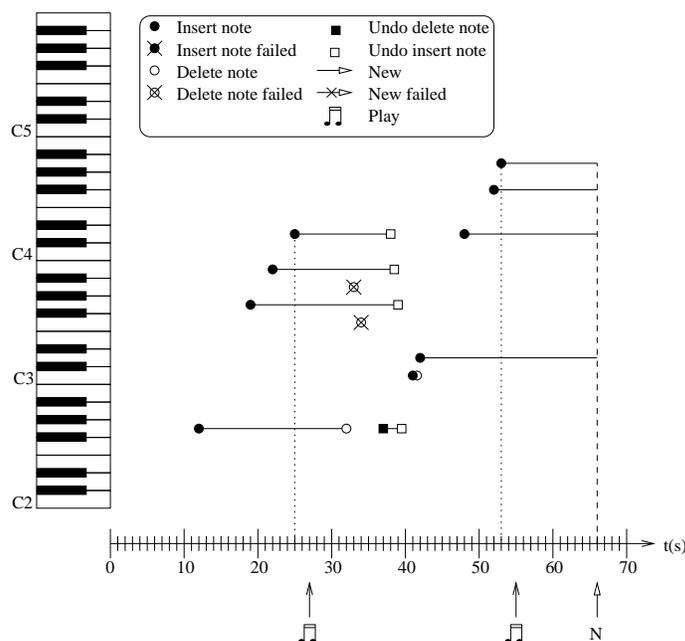


Figure 5: An Action Diagram

Summative evaluation

Aimed to assess not only the degree of faithfulness of the environment to the method, but also the educational benefits that such an environment can potentially bring to harmony teaching. The evaluation was carried out by three university harmony lecturers, in addition to two Artificial Intelligence students on the pilot sessions. The data gathered in the evaluation sessions (e.g. full audio recording, interaction log, etc...), together with their answer to a semi-structured interview, strongly suggest that the prototype faithfully represents Schoenberg's method of teaching harmony.

6. Conclusion

This paper presented a framework capable of enabling Schoenberg's method of teaching harmony. This method differs from most other harmony teaching methods in the sense

that it presents a consistent and systematic set of principles which are amenable to be modelled in a computer. The pedagogical constraints which guided the design and construction of the environment were presented and compared with the constraints found in traditional harmony teaching.

The formative and summative evaluation studies of the prototype learning environment suggest that materials of the method can be delivered, and can be made accessible to the user, by a computer-based environment embodying a computer model of Schoenberg's method of teaching harmony. These studies indicate that the proposed framework is a true and good embodiment of Schoenberg's method, and it seems to be worthwhile to expand further the prototype learning environment for real use in the classroom to evaluate the potential benefits of Schoenberg's method of teaching harmony to the learning of the subject by users in the target group.

References

- Brandão, M. (2002). *An Embodiment of Schoenberg's Method of Teaching Harmony in a Guided Discovery Learning Environment*. PhD thesis, University of Edinburgh, UK.
- Burns, H., Parlett, J. W., and Redfield, C. L., editors (1991). *Intelligent Tutoring Systems: Evolutions in Design*. Lawrence Erlbaum Associates, Hillsdale, New Jersey.
- Elsom-Cook, M. (1990). Guided discovery tutoring. In Elsom-Cook, M., editor, *Guided Discovery Tutoring - A Framework for ICAI Research*, chapter 1, pages 3–23. Paul Chapman Publishing, London.
- Gauldin, R. (1997). *Harmony Practice in Tonal Music*. W. W. Norton & Company, New York, first edition.
- Krumhansl, C. L. (1990). *Cognitive Foundations of Musical Pitch*. Oxford Psychology Series. Oxford University Press, New York, Oxford.
- Krumhansl, C. L. and Kessler, E. J. (1982). Tracing the dynamic changes in perceived tonal organization in a spatial representation of musical keys. *Psychological Review*, 89:334–368.
- Peters, G. D. and Miller, R. F. (1982). *Music Teaching and Learning*. Longman Music Series. Longman, New York; London.
- Piston, W. (1978). *Harmony*. W. W. Norton & Company, Inc., New York. Revised and expanded by Mark DeVoto; Second impression 1981.
- Riemann, H. (1895). *Harmony Simplified, or The Theory of the Tonal Functions of Chords*. Augener & Co., London.
- Rockstro, W. S. (1881). *Practical Harmony: A Manual for the Use of Young Students*. Robert Cocks & Co., London.
- Schoenberg, A. (1990). *Theory of Harmony*. Faber and Faber, London. Translated by Roy E. Carter, based on the third edition (1922).
- Schoenberg, A. (1989). *Structural Functions of Harmony*. Faber and Faber Limited, Bungay, second edition.