Developing a Software for Music Education: an Interdisciplinary Project

Susana Ester Krüger (EMBAP/ UFRGS/CNPq)
Eloi Fernando Fritsch (UFRGS/CNPq)
Luciano Vargas Flores (UFRGS/PROPESQ/CNPq)
Roges Horacio Grandi (UFRGS/FAPERGS)
Tiago Rubin dos Santos (UFRGS/FAPERGS)
Dr.ª Liane Hentschke (UFRGS)
Dr.ª Rosa Maria Viccari (UFRGS)

Universidade Federal do Rio Grande do Sul (UFRGS)
Av. Bento Gonçalves, 9500, Bloco IV Cx Postal 15064
91501- 970 Porto Alegre, RS - E-mail: fritsch@inf.ufrgs.br

Abstract

In order to analyze some questions regarding interdisciplinary between Music Education and Informatics [1], few aspects concerning the creation of music education software will be presented. To illustrate the integration between those two areas, we describe the experience of creating STR (Rhythmic Training System). This experience demonstrated the importance of *teamwork*. Each member of the team brought his/her expertise, helping to develop a program based on the most recent concepts of each area.

1. INTRODUCTION

The integration of different fields of human knowledge has become possible and necessary in many research projects, making the word *interdisciplinary* more and more usual. As the areas that interact within these projects depend straightly on the intended objectives, according to Giraffa (1995), they usually are correlated (p.11). Sometimes, the project foresees the necessity of integration; in other cases, this necessity is observed along its execution, leading to a re-structuring of initial plans. Although it is more adequate that any planning be flexible to the extent of allowing possible

[1] or Computer Science.

alterations aiming at quality improvement, a previous analysis of what will be necessary for its execution can help in the efficacy of the goals accomplishment. This way, it is adequate to know the possibilities and limits of each domain and to search, among them, subsidies that supply the arising necessities. According to Pimenta, apud Souza (1996), "plurality does not mean resigning identity" (p.12), that is, in projects that integrate different areas, each one works within his/her specific knowledge, sharing experience and aiming at objectives in common.

The integration between Informatics and Music in specific projects regarding the software creation has been required by musical enterprises, which have always pressed technology to refine musical instruments (Hunt and Kirk, 1997, p.152; Fritsch, 1995, p.76). Nevertheless, according to Hunt and Kirk (1997), such interaction is not considered an example of collaboration between technology and music, instead, it is technology "in the service of music". Technology can benefit from music in the way that "musical performance capitalizes its use of human resources", and can point "alternative approaches to user-oriented *design*" (p.152-3). The musical composition allows an analogy between the Computer Science creative processes and Music. For instance, in some cases, the software or compositions creation occur without a basis on previous models, leading to innovations in different aspects (ibid. p.153-4). And, usual "engineering tools, as computers and signal processing techniques, can be used directly in composition" (ibid. p.154).

Although studies concerning technology applied to composition and performance are predominant, some research projects have been searching the integration between Informatics and Music Education in software development for use in education. Such integration presupposes the consciousness of the necessity of these programs to be based on learning theories that take into consideration the student's cognitive and musical development (Giraffa, 1995, p.11).

The present work analyses some possibilities of interdisciplinary between Informatics and Music Education. Some theoretical questions regarding development of educational software for music are presented. Aiming at illustrating interdisciplinary, the creation process of STR (Rhythmic Training System) is reported. This system was developed by researchers from the UFRGS (Federal University of Rio Grande do Sul) *Computer Music Lab*, and the ULBRA (Brazilian Lutheran University).

2. INFORMATICS AND MUSIC EDUCATION

When developing a software for Music Education, one of the first questions that need to be addressed refers to the definitions of concepts and characteristics inherent to each kind of educational software. Giraffa (1995) comments that "all software can be considered educational, but its use must be inserted in a pedagogical context, where there is a methodology guiding the whole process" (p.105). The variety of ways of using software favors that conception that Music Education encompasses as much the formal or intentional education, to which the individual is submitted, as the informal or casual education, as the experience or influence of the individual environment (Beyer, 1994, p.41).

According to Swanwick (1979), in Music Education it is necessary to pay attention to the promotion of specific musical experiences, of different types, making possible for the students assume several roles in a variety of musical environments (p.42). This can be accomplished by having a balance in the musical activities offered to the students. In this sense, we highlight the *C(L)A(S)P Model: Composition, (Literature Studies), Audition, (Skill acquisition)* and *Performance*, proposed by Swanwick in 1979. The author defines each area of this Model as following:

Activity		Description
C	Composition	formulation of a musical idea. It is "all forms of musical invention (...), the act of making a musical object assembling sound materials in an expressive way"
(L)	Literature Studies	it includes "not only the contemporary and historical study of the literature *of* music itself through scores and performances but also musical criticism and the literature *on* music, historical and musicological"
A	Audition	"responsive listening as (although not necessarily in) an audience (...) encompasses an empathy with performers, a sense of musical style relevant to the occasion, a willingness to 'going along with' the music and (...) an ability to respond and relate intimately to the musical object as an aesthetic entity"
(S)	Skill Acquisition	aural, instrumental and notational abilities; it refers to the "technical control, ensemble playing, the management of sound with electronic and other apparatus"
P	Performance	"a very special state of affairs" (...) communicating music as a 'presence". Generally implies an audience – it does not matter his size or character (formal or informal)

Table 1: C(L)A(S)P Model (Swanwick, 1979, p. 43- 5)

The brackets ( ) in *Skill* and *Literature activities* are used by Swanwick in order to characterize them as secondary to the

educational process (knowledge *about* music). Their function would be to provide support to *Composition, Audition* and *Performance*, considered central for the student's musical development (a direct involvement *with* music) (ibid. p.44,47).

According to Hentschke (1997), *Composition* is the activity that request the greatest involvement, as the student can take decisions, thus changing the object. *Performance* offer further limitations, "because the individual cannot act, upon the creation of the musical discourse", although re-creation is possible to the act of interpretation. In *Audition*, or musical Appreciation the individual "does not have the chance of altering the object itself" (p.31). Although, according to the author, there are not studies that prove that an isolated activity propitiates musical development or that they are interdependent in this process (ibid. p.33), this set of activities has been a reference for many researches on Brazilian Music Education curricula (see Hentschke, 1996 a).

A great number of Music Education software, tend to approach theoretical topics (knowledge *about* music), instead of emphasizing activities that offer a direct involvement *with* music. This statement can be proved in the classification of software used within the music field. Higgins, apud Rudolph (1996), classifies software according to their content or activities, like: achivement testing, chords, intervals, clefs and transposition, identification of intervals, musical perception (harmonic and rhythmic), musical theory, instrument instruction, composition, conducting, history and appreciation, vocal instruction, and others (p.72). Bray (1997) distinguishes eight categories of musical software: encyclopaedia (sound combination, text, graphics and video) providing factual information about music, composer's biographies, study of specific musical pieces, instrumental tutor, instruction about musical styles, description of musical instruments, sound resource or bank ("for analysis, multimedia presentations, composition, and adding sound effects") creative tools (programs for composition – "to record sequences in music") and others (p.138-9).

Although it is necessary to develop more computer systems that enable individuals to perform activities that have a direct involvement *with* music (*Composition, Audition* and *Performance*), there are advantages in the use of programs that teach *about* music (*Skill acquisition* and *Literature*), as the musical theory ones. They can reduce the time dedicated to the refinement of musical technique and literature. Parrish (1997) verified a better result

during the classes, once the use of software for teaching and practicing of theoretical concepts resulted in a profit of three classes (136 minutes) that were dedicated to other activities, as Performance (p.98).

No matter the kind of Music Education software, it is important to pay attention to current pedagogic theories, coherent with educative objectives of the expected context. Mainly, the software must propitiates musical development in the most comprehensive way. According to Krüger (1996), a few Brazilian software of musical theory is developed according to recent studies on the cognitive and musical development; instead, they are based on traditional methods of presentation, concepts application and summative evaluation – and this can be seen in their technical structure, content and evaluation method (p.24). Is is important to point out the need to integrate studies on Music Psychology, and the knowledge of instructional attributes of technology.

Two researches on musical perception can be used as reference for the construction of rhythmic activities software. Sloboda (1994) reports the findings of Woodrow (1951) that, when "two successive isolated tones are presented for the discrimination of duration (i. e., subjects must say which is longer), then the longer the sounds are, the greater must be the difference between them if it is to be reliably detected" (p.29). This aspect can be important in the creation of rhythmic perception activities, mainly when only the listening perception is offered, without a visual aid.

Oliveira (1996) highlights the use of significant elements in Music Education activities. According to the author, melodies are reminded mainly by the reasons and relations that involved the listening of these melodies and not by notes or rhythmic figures of these melodies. Hence, the didactic work aiming at developing musical perception should prefer the use of significant melodies instead of isolated notes exercises and rhythmic figures with no sense of "gestalt", besides being presented in pleasant ways, aesthetically and artistically (p.74). Sloboda (1994) also comments that individuals "do not remember simple melodies in terms of precise pitches and durations but, in terms of patterns and relationships" and, "music which does not contain familiar patterns and structures cannot easily be represented in a listener's memory" (p.5). The number and complexity of these structures and patterns tend to increase with study, for that reason it is important to consider the availability of music that can be significant to students in several

areas. Parrish (1997) proved that software that use familiar folk songs and that relate concepts to the classroom practice are more efficient than those that give musical information without "reporting that information to the 'real' music" (p.91). For example, the STI program (System for Intervals Training), also developed by researches from the UFRGS *Music and Computer Lab* and ULBRA, uses known music in the activities of musical intervals perception (Fritsch, 1996).

Musical information, regarding factual knowledge, can not be considered the essence of musical knowledge (Swanwick, 1994, p.16). Thus, the selection of styles and the study of theoretical concepts need to be reinforced mainly in practice activities. The educator points out the importance of a careful selection of contents inserted in the creation of software that should rather be related to the individual's experience and have basis on music with expressive sense. Otherwise, may occur a "mechanising expressiveness by the use of harmonic and melodic loops and drum patterns, which do not serve the musical imperative of deviating fixed pulse and mathematically divided rhythms" (ibid. p.166).

Although it is possible to use all these researches in Music Education and Music Psychology, the parameters for the software creation need to be defined along with the computer engineers. Because they can say which data are possible to be inserted in the program, and for which requirements are necessary to develop specific tools. There are resources offered by Computer Science that have straight relation with software development for Music Education. When rightly used by interdisciplinary teams, they could generate programs with a good level of effectiveness in music classes from the perspective of both domains.

The use of technologies as hypertexts, multimedia, artificial intelligence, oriented programming, and visual programming can be worth in projects that aim at the development of Music Education software. If the educational software is intend to built aims at the musical realm, it presupposes multimedia use. Soares et al. (1992) define multimedia as "applications that interact with the user simultaneously to the use of several media, as audio, static images, images in motion, graphics and text, thus obtaining a more effective communication" (p.1). According to Fritsch (1996), musical software "need to combine the visual interface with musical interface, that is, to produce sounds according to the images and visual resources" (p.46). More than that, the knowledge required to deal with musical

information in the computer must be sought. Solutions to these problems are found in specific areas, as Computer Music and the studies on Interfaces Usability (HCI: Human- Computer Interaction) (Nielsen, 1993).

Within the Music Computation field, the designers are already using these technologies. However, each year new findings on Computer Science enrich the set of option that the programmer has in order to build systems. Only with frequent actualization of Computer Science it is possible to find the most adequate solution in programming and in the development of more interactive interfaces. As an example we can cite programming in JAVA language, which has been making possible the availability of programs through Internet. This new technology starts to be employed in distance learning. Programs for Music Education can make use of this technology increasing its diffusion and remote use in a Virtual Lab.

Another important collaboration for the construction of programs in Music Education is the knowledge of analysis techniques and software project. Such techniques are necessary for the solution of some problems in systems development, related to productivity, reliability and maintainability of the product to be obtained (Yourdon, 1992, p.131; Coleman et al., 1996, p.2). According to Nemetz (1995), problems in the development of hypermedia applications (which integrate hypertext and multimedia, as Music Education software) need adaptations in the analysis methodology and existing projects, taking into account some particularities restricted to this kind of application, such as: a) interactivity and navigation; b) visual aspects (user interface); c) multidisciplinary, due to multimedia use (p.18).

Although many researches on Music Education software in Brazil are in their beginning in relation to other countries, we observe the interest that teachers and programmers have in relation to the basis of their projects on up- to- date pedagogical conceptions, musical development theories and non- trivial techniques of Informatics. These principles can be found in the work of the UFRGS *Music and Computer Lab*. One characteristic of the projects is the active involvement of researchers from the Informatics and Music Education areas. Interdisciplinary is stimulated in order to allow new systems developed to aid musical experiences, considering the pedagogical context. Eventually we need to know how this interdisciplinary occurs and, to that end, the development of a Music Education software will be presented.

3. INTERDISCIPLINARY IN PRACTICE: STR

One of the musical systems in implementation at Computer Science Institute at the UFRGS *Computer Music Lab* jointly with Computer Science Departament from ULBRA is STR (Rhythmic Training System). This project was elaborated using the authoring software ToolBook II 6.0 (Asymetrix), due to its flexibility concerning the graphic and sonorous programming (Fritsch et al., 1998, p.211), and its conformity with the expected characteristics in environments of hypermedia modeling (Soares et al., 1992, p.85).

STR consist on several modules where the user can perform different activities and, according to Fritsch et al. (1998), it is elaborated for "students that already have a musical basis and want to exercise their rhythm knowledge in order to refine their perception. The system was developed to serve as a support to musical theory classes that involve rhythm" (p.217) and for teenagers over 12 years. Table 2 shows the Modules that integrate STR[2]:

MODULE	DESCRIPTION
Ditado Rítmico (Rhythmic Dictation)	Rhythmic perception activities in several difficulty levels, using C 4, in a quaternary beat. The teacher or the student can choose the figures he wants to work with in the text by configurating the system.
Repertório Rítmico (Rhythmic Repertoire)	Analysis and appreciation of rhythmic patterns characteristics of several styles and musical periods, and its possible to hear the whole sentence or only a rhythmic pattern. The sentence can be fully appreciated (rhythm, melody and harmony) or only its rhythm; the appreciation of the pattern emphasize only its rhythmic characteristics, using C 4 sound. As for the music to be worked, we opted for the classification as "musical styles", once this classification is widely known and used by many music instructors: a) Erudite – Baroque, Classic, Romantic, 20th Century; b) Popular – Brazilian, Foreign; c) Folklore – Brazilian, Foreign. From the 60 music, we cite *Berceuse (J. Brahms), Killing me Softly (C. Fox & N. Gimbel/Roberta Flack),* and *Nobody knows the trouble I've seen (North- american folklore).*
Recursos Rítmicos (Rhythmical Resources)	Study of examples of musical sentences that have specific rhythmic characteristics, as upbeat, augment point, ties, syncopation and triplets. The evaluation is done by the rhythmic perception of patterns that are chosen in order to form a rhythmic line. The student needs to choose four rhythmic cells of 16, that pertain to the characteristic which is being studied. These last are ordered in a rhythmic line, and can be appreciated.

[2] Further description can be found in Fritsch et al. (1998)

Composição Rítmica (Rhythmic Composition)	The student can create rhythmic patterns using different values that sum a quaternary beat, without a previous orientation. Different instruments can be chosen by the program for the execution. Patterns can be executed or transcribed for the accomplishment of other musical activities, such as instrumental performance.

Table 2: Modules that integrate STR

Starting from the *C(L)A(S)P Model* (Swanwick, 1979), we tried to offer a comprehensive musical experience: a) Literature studies and Audition, in *Repertório Rítmico* and *Recursos Rítmicos* Module; b) Composition, in *Composição Rítmica* Module, and c) Skill Acquisition, in *Ditado Rítmico* Module. As initially the software was not designed to be directly used in Performance, thus this activity was not considered. But, the teacher can elaborate activities of rhythmic execution in his/her class using the software. STR can be used in a direct way in four activities (Composition, Literature studies, Skill acquisition and Audition) and indirectly in one (Performance).

The programmatic content was analysed at the Paraná Music and Fine Arts School (EMBAP), in the discipline "musical theory" of the 4th Intermediate Year of Instrument, in order to relate the software to a specific step of music learning. The theoretical contents approached in the software were adjusted to the main contents taught at at this course. This way, the rhythmic contents inserted in STR could be elaborated aiming at a specific public, regarding the age range and the musical knowledge level, aiming later utilization in similar musical-pedagogic contexts. The main topics approached are: simple, composed and mixed beats, triplets in simple compasses, upbeat, syncopation and polyrhytmics.

For the modules that used music for the accomplishment of activities, such as *Repertório Rítmico* and *Recursos Rítmicos*, criteria for the selection of examples were set. They are: a) music history period, b) style, c) compass, d) tempo, e) main rhythmic characteristic, f) aesthetic value, g) minimum level (probable) of music knowledge by the target public. Besides this diversification, pieces for different formations were included, such as piano, trumpet, flute, choral, orchestra and chamber music. This concern with the comprehensiveness of styles, periods and instrumental groups is encouraged by Swanwick (1988), because it is not necessary to transmit an arbitrary or limited selection of idiomatic values, but to break with “restricted worlds of culturally defined reality, and promote imaginative criticism” (p.115).

The construction of each module tried to observe the musical-pedagogic aspects previously related. The choice of the demonstration form of the staves was based upon a research on some musical theory method, as Starer (1969), Priolli (1987) and Pozzoli (1983). We opted for using the stave of five lines with no clef and the note in the third space, in general with the C 4, considering a (Encore 4.2) (Figure 3):

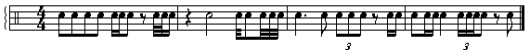

Figure 3: Staves format used in STR

The Metronome, used in *Repertório Rítmico* and *Recursos Rítmicos* Modules, allows the change of the music original tempo. Moreover, it is possible to study rhythmic details of this resource – for example, by the delay of the tempo – it is possible to make inclusions concerning the expressive character. According to Sloboda (1994), the emotional meaning of the music is not given only by the melody, but also by the rhythm, tempo, orchestration, and dynamics (p.61). Using the metronome, the students can observe the character of the piece in the original tempo and critically analyze the implications of the acceleration or delay of the tempo of the emotional and aesthetic quality of the work. Figure 4 presents the *Repertório Rítmico* Module.

Figure 4: STR – *Repertório Rítmico* Module

In terms of computational aspects involved, to implement data bank is a determining factor of quality and maintainability in any area of the human knowledge, when we want to organize and search data stored in a computer quickly and efficiently. Another important factor for the right implementation of database is to avoid negative

redundancies, that is, unwanted replication of data, what can provoke inconsistency of information besides overloading memory.

As for the interface, we tried to facilitate the operation, as well as to consider factors as color, buttons size and the importance of information at each moment. For example, when we ask to see the rhythmic pattern of a music, it is superposed to the general information. This transaction between rhythmic pattern and general information is accomplished by a single click of the mouse. The organization of the music data in a table, each one with its respective code, allows to access melodic and rhythmic examples recorded in a disk through programming methods. In order to guarantee the integrity of data, we opted to organize a table in a *dBase III Plus* format that makes possible, through the so called external routines, the recovering of data through *ToolBook II* language. As for the maintenance aspect, when the teacher researches and finds new data, activities or, simply, a new conception of teaching method, it is important that the knowledge basis stored can be altered or fed easily or in a short period of time. The logic implemented is essentially independent from the data structure, reaching the mentioned aspect. This characteristic of the program is according to the education presupposed related to the use of technology in Music Education recommended by Swanwick (1994, p.165- 6).

Since the *Recursos Rítmicos* Module (Figure 5) offers theoretical and practice activities, some criteria regarding the rhythmical characteristics of the music were observed. The approach, in educational terms, needs to be done in relation the specific characteristics of the works because, according to Swanwick (1988), “a characteristic is a distinctive element and makes difference; and one concept is a generalization. A concept calls attention to what is common, a characteristic impression us with what is unique in this context” (p.147). The characteristic of certain music can not be considered as a generalization, that is, an illustration of a certain composition technique, structure, harmony, rhythm or another aspect; but this aspect can be seen as a personification within a special context (ibid. p.147).

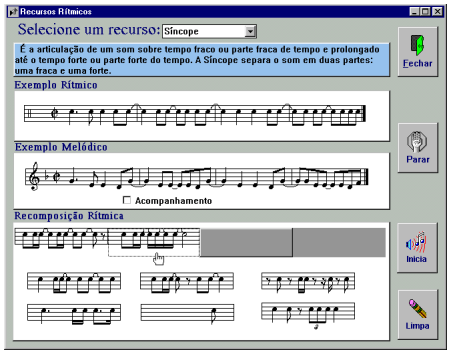

Figure 5: STR – *Rhythmic Resources* Module

We believe that most music of this Module are known by the users, as *Bagatella Op. 119 nº 1* (L. v. Beethoven), *Samba-le-lê* (Brazilian folklore) and *Garota de Ipanema* (Tom Jobim and Vinícius de Moraes). The way of working of the rhythmic characteristics of each piece can allow a better knowledge of their musical possibilities as a whole. This because the user can visualize and listen the characteristic rhythm of each piece (for example, in *Garota de Ipanema* , we emphasize the syncopation) in three different forms: rhythm, melody rhythm, and the rhythmic-melodic sentence with harmony. We propose an activity that begins from the rhythmic characteristic for musical sentence, and culminating in an activity that offers variety of rhythmical formation to be used in other activities external to the software.

The main problem found in the development of STR was a component that could play directly the MIDI events. How this implementation was not possible, other alternatives were tried. The execution of sound files in a WAVE form is not recommended because it is not very precise, an indispensable pre-requisite in this project. Another alternative was the use of pre-ready MIDI files, but it would be necessary to have a too large data bank to manipulate them. The definite decision was to create a “Dynamic Link Library” (DLL) to be used in a parallel with the *ToolBook II*. The software calls this DLL, passing a list with notes and their duration, tempo, presence or not of the metronome, initial counting and others as parameter. DLL records a temporary MIDI file with the chosen characteristics, which could be then executed by the software that calls it.

With this task we verified the necessary interaction between the areas involved in the project, in order to determine which parameters would be enough for the intended objective, and even in the definition of their formats (i. e., the form of the textual decodification of the notes sequence to be played).

4. CONCLUSION

This paper approached some creation principles of educational software for music in interdisciplinary projects that involved Informatics and Music Education. This experience proved the necessity of: a) be based on recent research of Music Education and correlated areas; b) use resources and special techniques of Computer Science; c) have interdisciplinary teams in order to reach the proposed aims. We emphasized, during the experience of the STR implementation, the increment of efficiency and quality in the development of the program, result of the interaction between the team staff. We formed a group where people of different areas work in the search for solutions at the same time and place, what makes possible to exchange knowledge quickly and clearly. As well as the doubts are immediately solved, avoiding their accumulation and waste of time researching the respective answers.

During the elaboration of STR, we verified the efficiency obtained due to interdisciplinary work. As necessities and knowledge within Informatics and Music Education fields are shared and immediately discussed, the researchers have been getting better results concerning efficiency in the construction of the program. Thus modules can be created according to pedagogic up-to-date and programmed principles using adequate technologies.

In the sequence of the project three evaluation of the software in the year of 1999 will be accomplished by different groups of subjects. The first evaluation will happen in a class of the Escola Técnica de Porto Alegre (Porto Alegre Technical School). The software will be applied on music classes, providing the maximum of activities diversification to the students – including Composition, Audition and Performance – with STR and without it. In these evaluation we intend to verify: a) the efficiency level of the software in teaching rhythmical contents, b) its adaptation to the estimated target-public, c) the possible relation between the software content and other ones, d) the validity and pertinence of the inserted resources, and e) social and musical questions related to its use. The

second evaluation will be in lab conditions, accomplished by a group of music educators from the UFRGS Post-graduating Course in Music Education. The third evaluation will focus on Music Education and teaching and learning theories that were the basis of its construction and the level of adequacy between these learning theories and multimedia resources of the software. At last, we consider that the use of STR, as a subside in several researches with different focuses, can contribute for the construction of programs with similar principles and musical-pedagogic contents.

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