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Abstract

Musical scores are some of the most important learning tools for musicians' acquisition of musical knowledge. However, despite their educational relevance, very little is known about how music students *conceive* of these cultural external representations. Given that these conceptions might act as mediators of students' learning approaches, the importance of knowing these conceptions seems evident in order to eventually change them. The general aim of this investigation was to study the conceptions of piano students at Spanish music conservatories by adopting a developmental-instructional perspective. The participants were 215 students at intermediate and tertiary degree levels, representing three levels of the collapsed variable age–level of instruction. Data were collected by means of a written open-ended task and analyzed by means of descriptive, parametric, and nonparametric statistical methods. The findings suggested that (a) students' conceptions were more sophisticated at higher age and education levels, (b) each developmental-instructional group typically focused on different musical aspects, which reflected an inclusive and hierarchical logic, and (c) five increasingly sophisticated conceptions could be identified among these students.

Keywords

conceptions, musical scores, external representations, music education, piano students, learning outcomes

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Introduction

Our research addresses a specific aspect of the implicit theories of learning and teaching held by instrumental students: their conceptions of musical scores as external representations. This article is focused on the field of music interpretation within the Western classical tradition. As is very well known, learning and teaching of this musical genre—unlike others (e.g., jazz, flamenco)—customarily requires the use of musical scores, cultural tools for external representation composed of a wide range of musical notations (Treitler, 1982). Within this classical instrumental tradition, many of the current curricula in different countries suggest that one central goal of teaching should be to promote students' active and constructive learning to help them to become capable, independent performers (Broomhead, 2001). To a certain extent, it could be argued that nowadays, instrumental teachers are expected to teach students to approach their learning as expert performers do (Hallam, 2007). Indeed, assuming the expert model as an "educational ideal" seems unavoidable if one considers the sophistication of professional performers' approaches to learning musical scores.

According to different research studies, expert musicians are characterized not only by how much they practice but especially by the quality of their practice (Duke, Simmons, & Cash, 2009; Jorgensen, 2002). Thus, during study time, they display a wide repertoire of learning strategies, of which they have a high degree of metacognitive control (Nielsen, 1999). Furthermore, professional musicians tend to hold sophisticated epistemological views regarding interpretation, grounded in *pluralism* and *perspectivism*, although obviously, each tries to define his or her own musical "identity" (Hallam, 1995). However, one could say that expert musicians are characterized not only by *how* they learn musical scores but also by *what* they learn from them, that is, by the wide variety of dimensions, elements, and skills on which they *focus* their attention during the different stages of musical score study and practice (Chaffin, Imreh, Lemieux, & Chen, 2003; Williamon, Valentine, & Valentine, 2002). This is the feature on which we focus our attention in this article.

Evidence suggests that professional musicians tend to display a general three-part pattern in their processing of musical scores, described by several authors as "macro-micro-macro" (e.g., see Lane, 2006). The first step in this process (macro), which sometimes occurs even before sight-reading or rehearsals begin, involves developing an artistic image of the scores on the basis of aspects such as their style, structure, and sound. This first internal "big picture" (Chaffin et al., 2003) has a pervasive effect on the second part of the processing pattern (micro), because it influences the procedures that expert performers display to acquire the basic elements of the scores (i.e., graphic notations) as well as to solve the technical difficulties that these elements entail (e.g., motor skills, relaxation, etc.). After both of these aspects are mastered, the artistic dimensions of the scores (macro) become the main focus of attention once again (i.e., interpretative, stylistic, aesthetic cues), in such a way that these more accurate expressive intentions help to improve and/or adjust the skills and levels of score processing previously developed. In summary, one could say that experts approach musical scores in sophisticated ways, given that they are able to process these external representations at very different levels, and that their "epistemic interest" leads them to focus mainly on the expression of the scores' artistic meaning and sense (Woody, 1999).

In contrast, research indicates that instrumental students do not approach their learning in this complex way, which seems logical if one takes into account their lower degree of expertise. According to a number of studies (e.g., Gruson, 1988; Hallam, 2007; McPherson, 2005), music learners tend to be focused entirely on the micro pattern of processing to which we previously referred. Although some changes in their approaches come about as expertise develops, students tend to concentrate first on playing the correct notes as well as on playing them at the correct pitch (in the case of nontemperate instruments, for instance). Attention is then directed to rhythm and technical aspects of playing. Finally, they become focused on reproduction of other graphic notations in the score (especially aspects such as dynamics and agogic notations). However, despite this strong "reproductive interest," many students, especially those at the lower instructional levels and younger ages, often appear to be unaware about the errors that they make (Hallam, 2007; McPherson, 2005). This might be because of their lack of appropriate internal aural "big picture" of the musical scores that they play.

From our point of view, to be able to explain, understand, and eventually change the ways in which students of different ages and educational levels approach their learning of musical scores, it is necessary to know, among other aspects, how they understand these as external representations (Pérez Echeverría & Scheuer, 2009). If an instrumental student—whatever the instrument may be—understands musical scores as simple collections of juxtaposed symbols (e.g., musical notes, rhythm, dynamics, and agogic notations), it seems logical that their approach to learning will be focused mostly on the precise reproduction of those symbols. In contrast, this hypothetical student probably will focus his or her attention not on analyzing the internal logic of the musical score (i.e., syntax and structure) or on understanding its artistic sense and meaning (i.e., at a stylistic, expressive, and communicative level) and even less on thinking about subtle aspects related to how the piece should sound. Changing the student's approach to learning would imply, among other things, that his or her teacher helps him or her to build a more sophisticated view regarding *what is written* in these cultural tools, both explicitly and implicitly (see Treitler, 1982). Thus, if we adopt a constructivist perspective on knowledge (Pozo et al., 2006), the study of these conceptions of musical scores as external representations becomes important from an educational point of view, given that to change the conceptions held by students, one must first precisely know which conceptions they hold.

To date, there are very few research studies that have approached this issue directly. Two exceptions are the studies by Hultberg (2002) and Reid (2001). In both cases, interviews were used as instruments to gather data. Samples of participants ($N = 11$ and 14, respectively) were selected a priori to maximize possible variations among the interviewees and were composed mostly of tertiary-level students. On the basis of Vygotsky's theory of cultural history, Hultberg identified two dichotomous conceptions regarding musical scores, which she called the *reproductive* and *explorative approaches.* In the first approach, musical scores were conceived as explicitly normative documents, which prescribed how to play and through which the performers had to be assessed. In contrast, in the second conception, the function of musical scores was understood as an invitation to seek out implicit meaning according to the musicians' criteria, although within a framework of agreed understanding with the composer of the particular piece. Reid, by using phenomenography as the research methodology, identified a wider spectrum of conceptions (or levels), which were defined as hierarchical and nondevelopmental. According to a criterion of increasing sophistication in meaning, these levels were as follows:

Level 1: Focused on technical aspects of playing the instrument
Level 2: Focused on reproduction of basic elements of musical scores
Level 3: Focused on learning musical meaning
Level 4: Focused on learning to communicate musical meaning
Level 5: Focused on learning to express personal meaning

In summary, both studies indicated the existence of a continuum among tertiary-level students' conceptions of musical scores as external representations. Adopting Scardamalia and Bereiter's (1987) classical terminology, the least sophisticated extreme might be called the "say the scores" conception, given that it was focused on the printed notation's literal reproduction, whereas the most sophisticated might be called the "transform the scores" conception, because scores were conceived as *epistemic* tools to construct artistic knowledge of an idiosyncratic nature. At the same time, Reid's (2001) work pointed out the existence of some "intermediate" conceptions between these two extremes, whose nature could be interpreted as inclusive and hierarchical.

Given these findings, the general purpose of this project was to investigate the conceptions that instrumental students from the Western classical tradition have about musical scores as external representations, by adopting a developmental-instructional perspective. More specifically, our interest was to answer five previously unexplored research questions: What conceptions about musical scores as external representations do students of different ages and educational levels hold? How do these conceptions evolve from the intermediate through the tertiary level? Which conceptions are more or less frequent at each educational level? To what extent do these conceptions respond to an inclusive and hierarchical logic? In what way does this integration occur?

To answer these questions, as will be described later, we decided to focus our study on piano students, given that this is the instrumental specialization of the first author of this article. Besides, in contrast with prior studies, we chose not to use interviews as a methodology to access students' conceptions. Instead, paper-and-pencil questionnaires were used. There were two fundamental reasons for this. First, from our theoretical perspective, the cognitive nature of these conceptions tends to be mostly implicit (see Karmiloff-Smith, 1992), and hence, it is often not possible to access them through explicit methodologies, such as interviews or direct questionnaires. Instead, more indirect methods seem more appropriate (for an in-depth rationale, see Pozo et al., 2006). In our study, we chose to implement a production task of learning outcomes that had been used in a prior study with piano teachers (see Bautista & Pérez Echeverría, 2008), because its features are coherent with our theoretical understanding of these implicit conceptions. Far from formulating an explicit question (e.g., How do you conceive of musical scores?), this task posed a hypothetical teaching–learning situation in which the research target topic was much less evident to the participants. Among other advantages, this methodological strategy substantially reduces social desirability bias in participants' answers and hence makes it possible to infer their more implicit beliefs. The second reason for our methodological choice was merely pragmatic. To achieve our goals, we needed a large and diverse sample that would have been impossible to access through a more time-consuming method, such as interviewing.

Context for the Research

This study was carried out in Spain with students at official conservatories of music. In this country, these are the only educational institutions where it is possible to achieve officially valid musical qualifications (i.e., recognized diplomas). The National Curriculum for Music and Arts Education (see Ley Orgánica de Educación [LOE], 2006) establishes that music instruction of all degree levels, including the lowest, has a specialized and professional nature. For this reason, music conservatories do not form part of the compulsory education system.

The professional music syllabi are structured into three degrees: elementary and intermediate degrees, which are usually studied within the same conservatory, taught by the same staff of instrumental tutors (with certified teacher status), and tertiary degree, which is studied at a different conservatory, taught by teachers with higher professional status (professors). In addition to studying their main instrument, during these degrees, students also are required to attend a number of other courses, which are defined by the National Curriculum (LOE, 2006). Table 1 summarizes its structure.

As students' educational level increases, they are required to attend the conservatory more often. Elementary-degree pupils typically go twice per week, normally during evening time, whereas the tertiary degree requires daily attendance.

Regarding entrance criteria, the curricular rules state that selection of students has to be based on their maturity, aptitude, and prior knowledge. From these orientations, which in our view lack precision, each conservatory has autonomy to design its own entrance examination.

Method

Participants

The participants were 215 piano students at 22 music conservatories (12 intermediate and 10 tertiary institutions) from 10 autonomous regions in Spain. These students

Table 1. Structure of Current Syllabi at Spanish Official Conservatories of Music

	Elementary degree	Intermediate degree	Tertiary degree
Years of study	4	6	4
Courses	Musical Language, Choir, and Ensemble	Harmony, Ensemble, Chamber Music, History of Music, and either Analysis or Composition Basics	Analysis, History of Music, Acoustics, Accompaniment and Transposition, Choir, Chamber Music, and several elective courses at the 3rd and 4th year, which define the students' major: performance or pedagogy
Approximate range of ages	From 8–9 to 11–12 years	From 12–13 to 18–19 years	From 19–20 to 23–24 years

were selected according to the three levels of the combined variable age–level of instruction and consequently formed three groups:

- Group I: Between 12 and 14 years old; first or second level of intermediate degree
- Group II: Between 17 and 20 years old; fifth or sixth level of intermediate degree
- Group III: Older than 22 years old; third or fourth level of tertiary degree

The features of these groups of students in relation to their gender, age, musical background within their families, major (applicable only to tertiary-degree students), and academic performance are shown in Table 2.

A total of 25 conservatories was invited to participate in the project (percentage of participation was 88%). Four were chosen by a criterion of easy accessibility, because the first author of this article had been a former student and maintained personal connections with some members of their boards of directors. The rest were selected randomly from the entire pool of conservatories in the country.

Materials

An open-ended paper-and-pencil task was used (see the appendix).[1] Participants were asked to imagine a hypothetical teaching–learning situation in which they had to teach an "average student" at their same level. After choosing an appropriate piano piece to be taught, they were asked to write down the five most important things that this hypothetical student should learn to be able to learn the target piece. The word *things* (in Spanish, *cosas*) was used as an easy way to denote learning outcomes. The use of that term was completely deliberate because in the language of the participants, it has a very unspecific meaning. In this way, we intended that each student freely focus on those aspects of musical scores actually considered "important" on

Table 2. Features of the Three Groups of Students

Variable	Group I	Group II	Group III
Gender			
Female	42	40	26
Male	45	40	22
Total	87	80	48
Age			
Range (years)	12.04–13.96	17.10–19.85	22.10–29.30
M (years)	13.34	18.19	24.35
SD	0.73	1.20	2.18
Musical background within the family			
Father and/or mother are professional musicians	18 (20.68%)	6 (7.50%)	2 (4.16%)
Other relatives are studying or working at conservatories	60 (68.96%)	31 (38.75%)	12 (25.00%)
Major			
Performance	—	—	44 (91.66%)
Pedagogy	—	—	4 (8.33%)
Final marks received during the last two years (scale 0 to 10):			
Range	4–10	5–10	5–10
M	7.24	7.61	7.74
SD	1.67	1.38	1.33

the basis of his or her most implicit conceptions. One table with five rows (for each of the five learning outcomes) was provided as well as a supplementary sheet of paper. No space limitation was imposed for responses. Students were required to carry out this task individually and without others' help. There were no time limitations.

Procedure

We first contacted the board of directors at the conservatories to inform them about the project and ask for their institutional support. After these permissions were granted, all the piano teachers were informed about the study (i.e., aims, target students, and procedure to be followed to administer and collect the documents). The following documents were used:

1. *Parental consent*, which had to be signed in advance by either the father or the mother of all minor students (<18 years old); only those whose parents consented to their participation were included in the final sample.
2. *Personal background form (anonymous)*, in which the students were asked about the issues described in Table 2.

3. *Research task*, which was carried out individually by the students within their classrooms under the supervision of their piano teachers (usually immediately following their piano lessons); all the necessary instructions were included in this document so that teachers did not interfere with students' answers.

Both teachers' and students' collaboration was voluntary. No material reward was given for their participation.

Design

The design used was ex post facto, simple, prospective, and cross-sectional. The independent variable was the combined variable age–level of instruction, with three levels described earlier. The dependent variable, students' conceptions of musical scores as external representations, was conceptualized on the basis of a set of seven descriptive and nonmutually exclusive response categories, which were defined post hoc to guarantee their suitability to describe as deeply as possible the learning outcomes written down by the students. Table 3 presents the definitions and examples of these response categories.

Each of these seven response categories presented two mutually exclusive modalities:[2] *yes* (i.e., the student's answer refers to this category) and *no* (i.e., the student's answer does not refer to this category). Therefore, each learning outcome was coded seven times, and hence, it might be potentially coded seven times in the modality *yes* (this would indicate that the learning outcome was extremely comprehensive in the sense of addressing all the response categories) or seven times in the modality *no* (which would indicate the opposite fact).

To validate this coding system, three judges—expert in both music performance and the theoretical framework of external representations—independently coded 20% of randomly selected data (i.e., 44 students × 5 answers per student, that is, 220 answers in total). Agreement rate was high (kappa = .921). The whole corpus of data was coded by the judge that, on average, had the highest agreement with the others (average kappa = .897).

Methods of Analysis

First, we carried out several statistical analyses in which the units of analysis were the students' answers (N = 1,075 learning outcomes): descriptive statistics and one-way ANOVA plus Tukey post hoc comparisons, to describe and compare the answers of Groups I, II, and III in terms of the quantity of response categories addressed in the learning outcomes, and chi-square tests and simple correspondence factorial analysis (SCFA), to analyze the possible associations between the three groups of students and the seven response categories. Next, an ascending hierarchical classification (AHC) analysis was performed to group the participants (N = 215 students)

Table 3. System of Descriptive Categories Used in Content Analysis of Students' Answers

Category	Definition	Example
1. Basic processing	The answer refers to one or several basic components of the score, such as key, meter, rhythm, tempo and metronomic directions; notes, rests, chords, arpeggios, scales and ornaments; dynamic and agogic notations; fingering; other graphic notations (i.e., pedal).	"Reading of the notes" "Mordents and trills" "Being respectful to the dynamic notations written in the score, and . . ."
2. Syntactic processing	The answer refers to one or several terms that in itself/themselves involve a syntactic processing of the score, such as phrasing, melody, motif, theme, voice, texture, variation, etc.	" . . . and also distinguishing the main melody from the accompaniment"
3. Analytic processing	The answer explicitly refers to the analytical processing of the score (i.e., formal, melodic, harmonic, motivic, etc.).	"Analyze the harmonic, melodic and formal discourse of the whole piece . . ."
4. Artistic processing	The answer refers to expressive, stylistic, communicative, aesthetic, or referential dimensions of the score.	" . . . in order to understand the meaning of the score, its style and its aesthetic"
5. Rote learning procedures	The answer refers to the application of rote procedures of acquisition, reading, and/or retention of the score during the student's sessions of individual practice.	"Memorizing the piece by practicing with separate hands, or by studying the different voices separately"
6. Psychomotor dimensions	The answer refers to the psychomotor dimensions of the performance (i.e., technical skills, body relaxation, digital agility, and accuracy, etc.).	" . . . and correction of the technique (passing the thumb and hand rotation)"
7. Sound physical characteristics	The answer refers to the physical characteristics and/or features of the sound produced by the performer (i.e., accurate, brilliant, clean, clear, powerful, etc.).	"The sound should be extremely clear and transparent in the Prelude"

according to the similarities of their answers. Statistical software SPSS (Version 14.0) and SPAD.N (Version 5.0) were used.

Results

The average number of response categories in which each learning outcome (N = 1,075) was coded according to the modality *yes* was the first measure we

Table 4. Number of Categories per Answer Where the Modality *Yes* Was Coded: Descriptive Statistics for the Three Groups of Students (N = 1,075)

	Group I (12–14 years old, first to second intermediate degree)	Group II (17–20 years old, fifth to sixth intermediate degree)	Group III (<22 years old, third to fourth tertiary degree)
Mean	1.324	1.835	2.092
Standard deviation	0.587	0.831	0.970
Standard error	0.028	0.041	0.062
Minimum and maximum	0–4	0–5	0–6
n (total answers per group)	435 (87 students × 5)	400 (80 students × 5)	240 (48 students × 5)

established to analyze and compare the conceptions of Groups I, II, and III. Table 4 shows the results of this descriptive analysis (see row called "Mean" as well as the other statistics).

A one-way ANOVA was performed to test the differences among the means presented in Table 4. The results revealed statistically significant differences, $F(2, 1072) = 86.252$, $p < .001$. Tukey post hoc comparisons indicated that the differences between all the groups (I, II, and III) were statistically significant at $p < .05$. For each higher level of the independent variable (age–level of instruction), there was a greater number of categories per answer in which the modality *yes* was coded. In other words, this indicated that the older the students and higher their level of education, the greater the quantity of response categories addressed in their descriptions of the learning outcomes.

Next, to analyze the possible associations between the three groups of students and the different response categories, chi-square tests of independence were applied on the observed frequencies of modality *yes* in each category. As shown in Table 5, the hypothesis of independence (or null hypothesis) was rejected in all cases ($Q < .001$) by showing the existence of statistically significant associations.

On the basis of the adjusted residual highlighted, it can be observed that Group I response rates were significantly higher than expected in Categories 1 and 5 and significantly lower than expected in Categories 2, 3, 4, 6, and 7. In contrast, students from Group III showed the opposite trend, except for Categories 1 and 6, where no statistically significant differences were found. Finally, Group II response rates were significantly higher than expected in Categories 2 and 6 and significantly lower than expected in Categories 1 and 5.

With the aim of providing a graphic representation of the previously described associations, an SCFA was carried out on the basis of the observed percentages (see row called "Obs. %" in Table 5). SCFA is a technique of multivariate analysis (specifically, a variant of principal component analysis) that relates two categorical variables by projecting their relations of proximity and/or opposition on a factorial plane (for a complete overview, see Lebart, Morineau, & Warwick, 1984). In our

Table 5. Observed Frequencies (Count), Observed Percentages (Obs. %), Adjusted Residuals (AR), and Statistics Resulting From Chi-Square Test in Each Response Category (*)

Category		Group I	Group II	Group III	Chi-square test
1. Basic processing	Count	288	198	124	
	Obs. %	66.20	49.00	51.66	
	AR	5,2[a]	–3,7[b]	–1,8	$\chi^2 = 26.946, d = 2, Q < .001$
2. Syntactic processing	Count	57	154	114	
	Obs. %	13.10%	38.50%	47.50%	
	AR	–10,1[b]	4,5[a]	6,6[a]	$\chi^2 = 107.399, d = 2, Q < .001$
3. Analytic processing	Count	6	32	49	
	Obs. %	1.37	8.00	20.41	
	AR	–6,7[b]	–0,1	7,9[a]	$\chi^2 = 75.369, d = 2, Q < .001$
4. Artistic processing	Count	33	78	73	
	Obs. %	7.58	19.50	30.41	
	AR	–6,8[b]	1,6	6,2[a]	$\chi^2 = 59.378, d = 2, Q < .001$
5. Rote learning procedures	Count	129	76	43	
	Obs. %	29.65	19.00	14.16	
	AR	4,2[a]	–2,4[b]	–2,2[b]	$\chi^2 = 17.953, d = 2, Q < .001$
6. Psychomotor dimensions	Count	45	164	64	
	Obs. %	10.34	41.00	26.66	
	AR	–9,3[b]	9,0[a]	0,5	$\chi^2 = 103.623, d = 2, Q < .001$
7. Sound physical characteristics	Count	18	34	34	
	Obs. %	4.13	8.50	14.16	
	AR	–3,8[b]	0,5	4,0[a]	$\chi^2 = 21.352, d = 2, Q < .001$

[a]Adjusted residuals higher than +1.96.
[b]Adjusted residuals lower than –1.96.

case, these two categorical variables were group (with three modalities: I, II, and III, as described earlier) and response category (with seven modalities: 1, 2, 3, 4, 5, 6, and 7; see Table 3 and/or Table 5). The two axes resulting from this SCFA explained 82.50% and 17.50% of the total inertia of the contingency table, whose value was 0.13627.[3] Eigenvalues of these axes were 0.1124 and 0.0239, respectively. According to customary criteria, modalities are taken into account for the interpretation of the factorial plane when their contribution to one or both axes is higher than the average value (i.e., 100/number of modalities). In our case, all the modalities of both group and response category exceeded the average values (100/3 and 100/7, respectively). Therefore, all of them are represented in Figure 1.

As can be observed, Axis 1 graphically displayed the developmental and instructional pattern of change mentioned earlier, because group modalities were projected by following an evident order (I → II → III) from the left- to the right-hand side of the

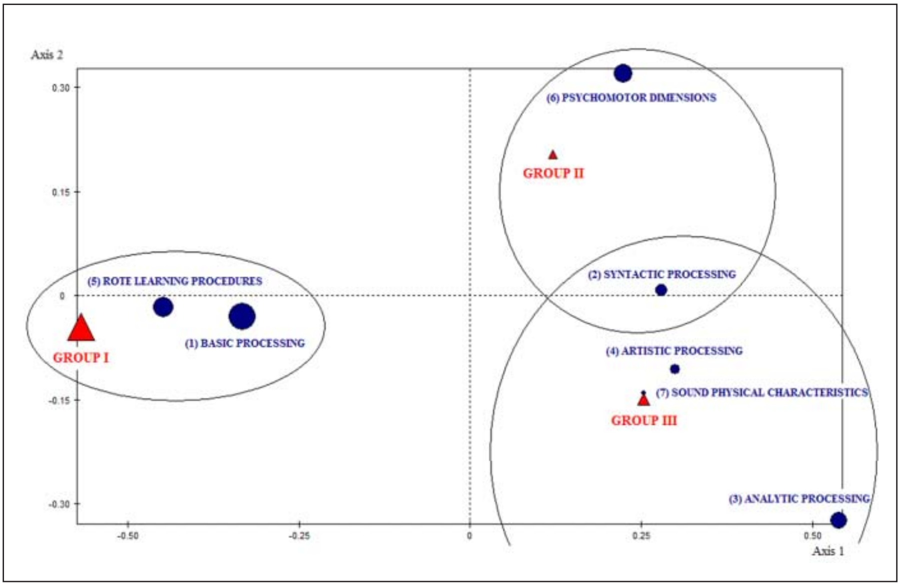

Figure 1. Factorial plane resulting from simple correspondence factorial analysis (SCFA)
The figure shows a two-dimensional representation of a three-dimensional space. The intersection of the four quartiles shows the location of the *centroid*, that is, the central point of gravity among the modalities. The closer to this point the location of one modality is, the more common is its presence among all the participants. The scaling of the two axes merely indicates spatial coordinates for modalities to be located easily. In SCFA, Axis 1 always shows the highest spread. Circles represent the modalities of the variable response category, and triangles the modalities of group. In both cases, the sizes of the figures provide an analogical representation of their contribution to the factorial axis.

plane. Three sets of associated modalities were found along this continuum. The first one (left-hand side of the plane), which was projected far away from the others, associated Group I with only two modalities: 1, *basic processing*, and 5, *rote learning procedures*. Because modality 1 also was referred very frequently to by Groups II and III (see Table 5), its location was slightly closer to the plane's center of gravity, and its contribution to the first factorial axis was high. The second and third sets of associated modalities (right-hand side of the plane) were connected to each other by sharing the modality 2. Indeed, the second set associated Group II with 2, *syntactic processing*, and 6, *psychomotor dimensions*; and the third set associated Group III with 2, *syntactic processing*; 3, *analytic processing*; 4, *artistic processing*; and 7, *sound physical characteristics*. In this sense, it could be argued that Axis 2 specifically showed the pattern of evolution in students' conceptions for Groups II and III by showing their progression in terms of both number and type of modalities in which these students focused their answers.

Finally, to identify the typologies of conceptions existing among the participants, as well as to analyze the distribution of the participants among these typologies, an AHC analysis was carried out. More specifically, we used Ward's clustering method (Ward, 1963; see also Lebart et al., 1984), which allows the grouping of participants according to the similarities in their types of answers. Hence, the units of analysis in this step were the 215 students. To perform the analysis, we first counted the number of *yes* codes that each student had in each of the seven response categories (notice that because the task required students to write down five learning outcomes, this number could range between 0 and 5 for each student in each response category). Next, on the basis of an exploratory analysis, several mutually exclusive modalities were created from each one of the seven response categories. Labels are shown in Table 6. By means of different codes (i.e., 01, 23, -0, +, etc.), these modalities describe the number of times that each particular category was identified among the total of five learning outcomes. Because these modalities were created post hoc, they were defined with the intention that participants would be evenly distributed across these modalities (in no case less than 15% of the total sample in each modality). The logic used to create the codes was as follows:

- *XY*, being consecutive numbers (i.e., 01, 12, 23, 34, 45): Either *X* or *Y* of the five learning outcomes referred to the response category (e.g., Ba01 means that either zero or one learning outcome referred to the category *basic processing*).
- *XY*, being nonconsecutive numbers (i.e., 35): Between *X* and *Y* of the five learning outcomes referred to the response category (e.g., Sy35 means that between three and five learning outcomes referred to the category *syntactic processing*).
- -*X*, with dash (i.e., -0, -1): *X* of the five learning outcomes referred to the response category (e.g., An-1 means that one learning outcome referred to the category *analytic processing*).

In the case of Category 7, *sound physical characteristics*, only two modalities were created because of its low rate of response:

- SPC–: None of the learning outcomes referred to this response category.
- SPC+: Some of the learning outcomes referred to this response category.

On the basis of both the hierarchical classification tree and the dendogram of Euclidean distances, which are not presented here because of space limitations, we decided to split the sample into five classes (Iteration 425, Index 0.07610). Thereby it was possible to differentiate between those classes which will be called Class 3 and Class 4 (otherwise, these two classes would have included more than 44% of students). Table 7 shows the response modalities associated with each class (only those whose eigenvalues were higher than ±1.96 are presented, with $p < .001$). The levels of the independent variable, group, that resulted in overrepresentation in each class are presented as well. Dashes (—) indicate that none of the modalities of the category was overrepresented in the class.

The composition of these classes in terms of frequency and percentage of students, regarding both the levels of the group variable and the total sample, is reported

Table 6. Labels of Modalities for the Ascending Hierarchical Classification

Category	Modalities		
1. Basic processing	Ba01	Ba23	Ba45
2. Syntactic processing	Sy-0	Sy12	Sy35
3. Analytic processing	An-0	An-1	An23
4. Artistic processing	AR-0	AR-1	AR23
5. Rote learning procedures	LP-0	LP-1	LP23
6. Psychomotor dimensions	Pm-0	Pm12	Pm34
7. Sound physical characteristics	SPC–	SPC+	

Table 7. Outline of the Classes on the Basis of Their Overrepresented Modalities

Category	Class 1	Class 2	Class 3	Class 4	Class 5
1. Basic processing	Ba45	—	Ba01	—	Ba01
2. Syntactic processing	Sy-0	—	Sy12	Sy35	Sy35
3. Analytic processing	An-0	An-0	An-1	An-1	An23
4. Artistic processing	AR-0	AR-0	—	AR23	AR23
5. Rote learning procedures	LP23	LP-1	LP-1	—	LP-0
6. Psychomotor dimensions	Pm-0	Pm34	Pm12	Pm12	Pm12
7. Sound physical characteristics	SPC-	—	SPC-	SPC+	SPC+
Associated with	Group I	Group II	Group II	Group II	Group III

in Table 8. The chi-square test allowed us to reject the hypothesis of independence between the variables group and class ($\chi^2 = 116{,}594$, $d = 8$, $Q < .001$). On the basis of the resulting adjusted residuals, one asterisk (*) indicates the frequencies of students whose responses were lower than expected in each class, and two asterisks (**) those frequencies that were higher than expected.

The descriptions of these classes are presented in the following sections according to a criterion of increasing sophistication. Each class will be named with a header that will aim to summarize its most outstanding features. Next, the constitution of the class will be reported as well as its associated modalities and the similarities and/or differences with the previous class.

Class 1: Musical scores as collections of symbols to be processed. Class 1 was composed of 30.23% of the total sample (highest frequency; overrepresented by Group I students). The answers of these students focused on the basic processing of the scores (Ba45) as well as on the learning procedures required to carry out this processing (LP23). Because the rest of the dimensions were not mentioned, we consider that this class reflected a strongly reproductive view of musical scores by representing the most naive and least sophisticated conception.

Class 2: Musical scores as collections of technical problems to be solved. Class 2 was composed of 13.95% of the total sample (fourth-highest frequency; overrepresented

Table 8. Composition of the Classes: Relative and Total Frequencies and Percentages

Class	Group I		Group II		Group III		Total	
	n	%	*n*	%	*n*	%	*N*	%
Class 1	57 (**)	65.00	4 (*)	5.00	4 (*)	8.33	65	30.23
Class 2	9	10.34	18 (**)	22.50	3	6.25	30	13.95
Class 3	12 (*)	13.79	24 (**)	30.00	10	20.83	46	21.39
Class 4	9 (*)	10.34	26 (**)	32.50	14	29.16	49	22.79
Class 5	0 (*)	0.00	8	10.00	17 (**)	35.41	25	11.62
Total	87	100.00	80	100.00	48	100.00	215	100.00

On the basis of the resulting adjusted residuals, one asterisk (*) indicates the frequencies of students whose responses were lower than expected in each class, and two asterisks (**) those frequencies that were higher than expected.

by Group II students). A strong interest in psychomotor dimensions of performance (Pm34) emerged among these students (i.e., technical skills, relaxation, corporal control), whereas rote learning procedures were given slightly less attention (LP12). Several modalities were shared with Class 1 (An-0, AR-0), but others did not achieve statistical significance. Therefore, from our point of view, this class might be reflecting a slightly more sophisticated conception than the previous one, although its nature would be, in essence, reproductive as well.

Class 3: Musical scores as external representations that begin to be seen as possessing an internal grammar. Class 3 was composed of 21.39% of the total sample (third-highest frequency; overrepresented by Group II students). References to syntactic and analytic processing timidly emerged within this class as foci of attention (Sy12, An-1), whereas references to basic processing and psychomotor dimensions were less frequent than in previous classes (Ba01, Pm12). Therefore, it could be argued that this class might be reflecting a transitional conception, halfway between the reproductive and epistemic poles.

Class 4: Musical scores as external representations that can be syntactically understood, performed, and communicated. Class 4 was composed of 22.79% of the total sample (second-highest frequency; overrepresented by Group II students). Members of this class made a high number of references to the syntactic processing of musical scores (Sy35), although their interest in analytic processing was scarce (An-1), similar to students from Class 3. Nevertheless, the most outstanding features of this class were the relatively frequent references to the artistic processing of the scores (AR23) and the strong interest in the physical characteristics of sound (SPC+). The inclusion of these elements as foci of attention allows us to infer a relatively sophisticated conception, characterized by aspects such as expression, communication, and syntactic understanding of the scores. However, because analytic aspects were mentioned scarcely and references to artistic processing were not very frequent, we consider that this class might be reflecting a low-level epistemic conception of musical scores.

Class 5: Musical scores as external representations that can also be analyzed as a whole. Class 5 was composed of 11.62% of the total sample (lowest frequency;

overrepresented by Group III students). Unlike in the previous class, a higher interest in the analytic processing of the scores (An-23) emerged among these students, showing a slightly more sophisticated view of musical scores. Because the rest of associated modalities were in essence similar and references to analytic processing were not very frequent, it could be argued that this class might be reflecting a medium-level epistemic conception.

Conclusions and Discussion

The data analysis presented in the previous section allows us to draw several conclusions about these Spanish piano students' conceptions of musical scores as external representations. First, on the basis of the descriptive and parametric analysis, it can be stated that higher complexity of students' conceptions is associated with both higher age and educational levels (Groups I < II < III), because the sets of learning outcomes produced by these three groups made progressive reference to more levels of processing, dimensions, and/or elements of musical scores. This finding, which is completely coherent with some general theories of knowledge acquisition (e.g., Dienes & Perner, 1999; Karmiloff-Smith, 1992), indicates that the development of instrumental expertise is associated with the student's capacity to become more aware gradually of the existence of different musical components as well as with the capacity to make these musical components cognitively more explicit. In this sense, one could say that developing more sophisticated conceptions of musical scores would require first being aware of their multidimensional nature, in other words, knowing the broad spectrum of information that these cultural representations code both explicitly and implicitly (Treitler, 1982).

Second, the results of both chi-square tests and SCFA have indicated that each developmental-instructional group typically focused its attention on different musical aspects. Therefore, Group I was exclusively focused on the acquisition of the scores' basic components (i.e., graphic notations) as well as on the rote learning procedures required to carry out this basic processing. In other terms, one could say that this group was mainly engaged in the micro pattern of processing described in the Introduction to this article and paid no attention to more complex musical dimensions (Lane, 2006). This certainly reminds us of the learning approaches displayed by the most novice instrumental students (see Gruson, 1988; Hallam, 2007; McPherson, 2005). On the other hand, both psychomotor dimensions and syntactic processing of musical scores were the most important foci of attention for Group II. Interestingly, students from this group often did not make explicit those aspects referred to by Group I. We could infer that these aspects, especially the basic components, were included tacitly or implicitly in their answers. For example, "distinguishing melody and accompaniment" obviously requires a prior mastery of a number of basic components, such as keys, notes, and figures. Similarly, "passing the thumb correctly in the high speed scales" obviously requires a previous grasp of these scales. In short, musical notations seemed to become relatively "transparent" for students in Group II, as single letters would become for expert readers (Scardamalia & Bereiter, 1987). Therefore, similarly to Reid's (2001) study, one might conclude that the conceptions most typically held by Group I and Group II reflected an inclusive and hierarchical logic. The same could be said about Group III. Besides referring either explicitly or implicitly to those aspects on which the former groups focused, these tertiary students also incorporated frequent references to the analytic and artistic processing of musical scores as well as references to subtle aspects related to how the pieces should ideally sound. Thus, to a certain extent, their answers remind us of the macro pattern of processing displayed by expert musicians (Chaffin et al., 2003; Williamon et al., 2002; Woody, 1999).

Despite these associations reflecting the most general tendencies in these three groups, the AHC has allowed us to identify five subtly defined, well-differentiated conceptions. From the least sophisticated conception, which was held by the majority of Group I students, musical scores were conceived essentially "as collections of symbols to be processed" (Class 1). Furthermore, the evidence suggests the existence of another conception in which scores are understood "as collection of technical problems to be solved" (Class 2). Given that this second perspective typically was held by students from Group II, it might be argued that the interest in psychomotor dimensions entails a slightly higher level of complexity. Interestingly, this idea contrasts with Levels 1 and 2 suggested by Reid (2001), which indicated the reverse hierarchy. Regardless of these differences, it seems clear that both conceptions underlie the most reproductive approaches to these external representations (Hultberg, 2002). At an intermediate point of sophistication, we found another conception in which scores were conceived "as external representations that begin to be seen as possessing an internal grammar" (Class 3), because syntactic and analytic aspects slightly emerged as foci of attention. This perspective is overrepresented also within Group II. The fourth conception, which was held almost equally by students from Groups II and III, reflected an incipient epistemic view of musical scores, which began to be conceived "as external representations that can be syntactically understood, performed, and communicated" (Class 4). Indeed, the emergent interest in the physical characteristics of sound, the relatively frequent references to artistic aspects, and especially the scarce references to analytic aspects allowed us to infer a low-level epistemic conception. Finally, the slightly higher number of references to scores' analytic processing identified among students from Group III allowed us to infer a medium-level epistemic conception, in which scores begin to be viewed "as external representations that can also be analyzed as a whole" (Class 5).

These findings seem to fit with the developmental-instructional patterns of change in young students' learning theories of other domains of knowledge, such as reading (e.g., see Scheuer, de la Cruz, Pozo, Huarte, & Sola, 2006), mathematics (e.g., see Brizuela, 2004), or drawing (e.g., see Scheuer, de la Cruz, & Pozo, 2002), in the sense of reflecting increasingly sophisticated conceptions associated with increases in both learners' age and expertise. However, we cannot forget the cross-sectional nature of this study. The existence of this changing process in music students' conceptions might therefore be posed as a hypothesis for further investigation.

Longitudinal studies should be carried out to maintain or reject it. Interestingly, we have not identified a high-level epistemic conception, that is, a conception mainly focused on scores' "big picture" (Chaffin et al., 2003), artistic meaning and sense (Woody, 1999), or macro levels of processing (Lane, 2006). This result might suggest that the acquisition of a truly epistemic understanding of these cultural representations is a very complex and difficult cognitive achievement, as much as the acquisition of constructivist learning theories in other academic domains (e.g., see Pozo et al., 2006). In this sense, it seems clear that these piano students still have a long way to reach the conceptions and approaches typical among expert musicians. On the other hand, these findings also might indicate that the instruction received by these Spanish piano students did not promote this epistemic understanding. In fact, in one of our previous studies with piano teachers, in which the same research task was implemented (Bautista, Pérez Echeverría, & Pozo, 2009), this high-level epistemic conception was identified among only a small percentage of teachers. According to several investigations carried out within music conservatories in Spain (for an overview, see Pozo, Bautista, & Torrado, 2008), the predominance of very traditional general theories of music learning and teaching still seems evident among instrumental teachers from this country.

The educational implications that arise from this study suggest the need for implementing teaching strategies to foster changes in instrumental students' conceptions, regardless of their age and level of instruction. First, music teachers should identify the conceptions held by each of their students to find out which levels of processing, dimensions, and/or elements are not taken into account (or made explicit). From our point of view, the task used in this study could be a very appropriate tool for this purpose. Next, on the basis of these prior assessments, teachers might design and implement sets of activities specifically oriented to highlight for students the multidimensionality of these external representations (i.e., tasks concerning syntactic and/or analytic processing for students to understand the "internal grammar" of music; readings about the different artistic periods to "discover" the implicitly coded stylistic and aesthetic dimensions; listening to different interpretations of the same piece to compare aspects such as expressiveness and sound; and so forth). Within these didactic sequences, special attention should be paid to those aspects that we have called artistic and analytic processing because, as the evidence presented in this article has shown, they were not considered important by many of the students (especially those at the lower levels of instruction and younger ages). Finally, it would be necessary for teachers to involve their students in sophisticated processes of reflection about their conceptions by emphasizing metacognitive activities through which students could become aware of how these conceptions influence their learning approaches.

Several considerations need to be underlined with respect to the weaknesses and limitations of this study as well as about the future lines of research. To begin, it would be necessary to analyze the generalizability of the findings presented, for instance, by comparing the conceptions of students specialized in different kinds of instrument (e.g., monophonic vs. polyphonic) or in different musical traditions (e.g., classical music, jazz, ethnic music) as well as of those receiving instruction with different teaching approaches (e.g., traditional vs. constructivist) or even under different education programs in different countries. In addition, although the topic addressed in this study is important in and of itself, it should be followed up with (a) further examinations of what these piano students actually do while learning musical scores, to clarify the complex relations between conceptions and practices, and (b) intervention studies to foster (eventually) changes toward the acquisition of more sophisticated and epistemic conceptions of musical scores.

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Appendix 1

Open-Ended Task Used in the Study

Imagine the following situation:

> John is a piano student at your same level in the conservatory. His expertise on the piano is "average" for that level. You are his piano teacher. Think of a piano piece well known by you that, in your opinion, could be appropriate to be learned by him in this year (the piece might be one of those you have already studied). Please tell us what piece you have thought of:

Title and composer:

To continue, please have at hand the score of this piece in case you need to check it. Now tell us which are the "FIVE MOST IMPORTANT THINGS" that, from your point of view, John should learn in order to LEARN this piece. Write them down in the five boxes in the next table. PLEASE FILL IN ALL THE BOXES. You can use as much space as you need.

Notes

1. Students' accurate interpretation of this task was checked in a previous pilot study. Notice that the version implemented was written in the Spanish language. The version presented in the appendix is the literal translation into English.
2. In this article, the term *modality* (or *modalities*) will be always used to refer to different values presented by categorical variables (i.e., categories).
3. It is important to explain that inertia means variance in the context of correspondence analysis. Total inertia is the sum of eigenvalues and reflects the spread of the modalities around the centroid of the plane. Its value is proportional to the chi-square statistic, which evaluates the association between two variables (in our case, group and response category).

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