Chapter 5

A multidimensional taxonomy of digital learning materials for music education

Federico Avanzini, Adriano Baratè,
Luca A. Ludovico, and Marcella Mandanici

Introduction

The concept of *smart education* effectively describes learning in the digital age. This subject is tightly related, but not limited, to the application of technology to educational activities. On one side, the development of new technological devices enables students to learn more effectively, efficiently, flexibly, and comfortably (Zhu, Yu, & Riezebos, 2016). Learners can now utilize smart devices to access digital resources through network technologies, also in mobility, and to immerse in both personalized and seamless learning. On the other side, technology *per se* is not sufficient: It must be coupled with novel pedagogical approaches aiming to use it profitably. In this context, pedagogy as a science has to engage in a new research direction: smart pedagogy (Daniela & Lytras, 2018). The focus on smart education and, consequently, on smart pedagogy has recently become a new trend, and the field of music teaching and learning is no exception.

We will face the problem of smart education from two points of view. First, we will address smart learning materials, namely those technologically enhanced aids for music learning and teaching. Examples range from music documents suitably encoded to meet specific pedagogical needs to augmented-reality environments to foster an embodied learning of music. Secondly, we will propose a smart methodology to address user-tailored teaching/learning challenges.

The remainder of this chapter is organized as follows:

- Section 'Technology and music education' will provide context information and relevant examples about technological approaches for music learning;
- Section 'A multidimensional taxonomy' will introduce a multidimensional taxonomy as a tool to systematize music learning materials;
- Section 'An example of classification' will present a clarifying example;
- finally, section 'Conclusion and future work' will draw conclusions and shed some light on future developments.

Technology and music education

In this section, we will discuss the state of the art about technology in music education. In detail, we will address the most relevant attempts to systematize music and technology-integrated learning and discuss some innovative technologies and their implications on smart music education.

Sound and music computing education

About ten years ago, internationally renowned experts authored a document titled 'A Roadmap for Sound and Music Computing' (Serra, Leman, & Widmer, 2007). The aim was to identify, characterize, and propose strategies for tackling the key research challenges that such a discipline was expected to be facing in the next 10-15 years. Emphasizing the need for a tight link between sound and music education, computing, and research, such an initiative proposed guidelines for higher-education programmes by defining a set of content areas: acoustics, audio signal processing and modelling, hardware and software systems, interaction and design of multimodal interfaces, music information retrieval and sound analysis, systematic musicology, music perception and cognition, and sound design and auditory display. This effort has been recently revised on the basis of technological and pedagogical advancements (Avanzini et al., 2019).

An important role was also played by the IEEE[1] Technical Committee on Computer Generated Music (1992–2013), supported by the IEEE Computer Society, which contributed to the definition of IEEE and ACM[2] curricula in the Sound and Music Computing area.

The mentioned efforts are useful to remark some relevant aspects. First, by proposing a suitable body of knowledge for future experts in the music domain, they show the heterogeneity of competences required to design and implement smart learning materials. Moreover, the multiple dimensions that can characterize their applicability (who are they designed for? what are their goals? to which educational context are they meant to be applied?, etc.) are a strong motivation for the present work, as we will explain in section 'A multidimensional taxonomy'.

Technological advances for music education

In this section we will focus on novel computer-based approaches and recent technological advances that are revolutionizing the educational field in general, and present interesting implications on music learning, too.

An approach that is currently inspiring several learning activities is the one of computational thinking (Wing, 2008), whose main goal is to teach how to tackle problems in view of finding out possible solution schemes apt to be automatically carried out by a computer. This approach can be highly effective in introducing young students to the scientific domain, improving their performances in STEM (science, technology, engineering, and mathematics) fields.

Music can foster the development of computational thinking skills in students mainly in two ways: on one side, by soliciting computational analysis of already available music works, and, on the other side, by encouraging processes of algorithmic generation followed by analytical processes. Examples include programmable robots inspired by Music Information Robotics (Kapur, 2005; Ness, Trail, Driessen, Schloss, & Tzanetakis, 2011; Solis & Takanishi, 2007), music programming puzzle games (Kumar, Dargan, Dwivedi, & Vijay, 2015), and coding-oriented approaches to music teaching (Baratè, Formica, Ludovico, & Malchiodi, 2017).

Another approach, not novel in the field of digital information representation but still very timely, is that of multi-layer descriptions. In this context, the basic idea is to have the description of a composition as rich as possible, including within a unique framework the heterogeneous aspects that can characterize the piece: logical, structural, notational, audio information, and related metadata (Haus & Longari, 2005). Currently, there are relevant examples of standard formats supporting multi-layer representation of music in the digital domain, such as IEEE 1599 and MusicXML/MNX (Baratè, Haus, & Ludovico, 2019). Their potential for music education has been explored in several scientific works, including Baratè, Bergomi, and Ludovico (2013) and Ludovico & Mangione (2014). In the context of an educational experience, multi-layer descriptions of music may enable a number of advanced applications and customizations, in accordance with the principles of smart pedagogy (Daniela, 2019).

An emerging trend in technologically enhanced education is 3D fabrication. Its pedagogical implications are rooted in the theory of tangible user interfaces (TUIs). This kind of interface lets a person interact with digital information through physical objects and the environment by taking advantage of the human ability to grasp and manipulate tangible shapes and materials. The theoretical principles of TUIs go back to hands-on education ideas proposed by Frobël and Montessori at the turn of the 20th century. In the digital domain, one of the earliest works is represented by Papert (1980). More recently, Zuckerman, Arida, & Resnick (2005) proposed a framework for tangible interfaces in education directly related to the principles enunciated by Frobël and Montessori. Additionally, Ishii (2008) introduced the term *tangible bits* to denote approaches that give physical form to digital information and make bits directly manipulable. A recent and comprehensive review about the relevance of TUIs as complementary tools for early spatial learning in cognitive development can be found in Baykal, Veryeri Alaca, Yantaç, and Göksun (2018). Among a number of positive effects of TUIs, research has highlighted increased learning performances for students; thanks to the role of manipulation and embodiment in enactive learning. TUIs also proved to be a valid tool to facilitate peer cooperation, by allowing several children to be active simultaneously, and inclusion, by allowing visually impaired children to discover the functions of objects through their shape and texture.

In music education, the adoption of TUIs is not particularly extensive, with the noticeable exception of virtual music instruments that, using manipulative interfaces and fiducial markers as controls (e.g., the Reactable), allow to associate music parameters to the features of physical objects. The advent of low-budget 3D printers can be a game changer in TUI-based education, letting learners design, implement, and fabricate their own tangible interfaces. Heterogeneous applications to the field of music education have been recently explored (Avanzini, Baratè, & Ludovico, 2019), including the definition or customization of 3D models to realize simple sounding objects, fabricate music-related action figures, and produce a user-tailored tangible music notation. All the mentioned case studies present relevant features for adaptive, customizable, and technologically enhanced didactic activities, thus becoming examples of smart learning materials. Moreover, 3D printing implies the use of devices and specific software tools that foster the development of computational thinking skills.

A technology that, in the near future, is likely to have a deep impact on society is the latest generation of wireless mobile communications, known as 5G. It introduces significant improvements with respect to current networking technologies in terms of a larger bandwidth, a more reliable service, very low latencies, and a higher density of devices (Osseiran et al., 2014). Thanks to the expected features of 5G, it is possible to conceive innovative educational activities: virtual lessons where learners can cooperate and interact in real time with the teacher and other students; sensor-based applications based on the principles of the *Internet of Things* to education; and laboratory experiences as realistic as in presence through, e.g., virtual reality platforms (Baratè, Haus, Ludovico, Pagani, & Scarabottolo, 2019). Smart-pedagogy musical applications based on 5G may include remote interactive classes for instrumental practice, cooperative music performances over the network, the implementation of customizable virtual musical instruments, embodied experiences through an extensive use of wireless sensors for body control of music parameters (Baratè et al., 2019).

A multidimensional taxonomy

In this section, we will discuss the axes that will be adopted in our multidimensional taxonomy for digital learning materials in use for music education. The list of axes we will present does not claim to be complete. Rather, our goals are, on one side, to demonstrate that such a classification task requires a multidimensional approach, and, on the other side, to provide heterogeneous and meaningful examples that can guide the user in the extension of our approach and in the detection of other dimensions.

From a methodological point of view, we will adopt a top-down approach, first trying to infer the general characteristics that may distinguish different types of axes, then applying this theoretical structure to practical examples.

Categories of axes

A high-level analysis of the distinguishing features that classification dimensions present can help to unveil the existence of well-defined categories of axes. First, we have to consider the heterogeneity of value types potentially hosted on axes: They can be numbers (integers, fractions, decimals, etc.), textual descriptions, dates, Boolean values, and so on. The values of a given type can present an implicit and commonly accepted order, as in the case of numbers or dates, or be unsorted, as in some enumerations where there is no clear criterion to define the type of sorting. Please note that, in the latter case, neighborhood as well as other topological considerations could not imply any specific property.

A distinction to stress is between axes containing a predefined number of discrete values, such as in an enumeration, against axes characterized by continuous values, where you can select any value between a minimum and a maximum. A particular case of the former category is the binary choice between two values, such as yes/no, true/false, black/white, etc.

Another distinction occurs between single-value and multiple-value dimensions. In the former case, for a given axis any object we want to classify can assume only one value, whereas in the latter it can span on multiple and potentially non-contiguous values.

Finally, we can recognize mutable and immutable categories of axes. In the former case, their meaning changes depending on the context (culture, geographical area, etc.), as what typically happens for enumerations. Conversely, immutable categories host data that remain unchanged in different contexts, a behaviour often associated to numeric values.

Examples of axes

In the following, we propose a list of axes that may be used to categorize digital learning materials.

1. *Target age*: This axis represents the age of the intended audience for the learning object under observation. Conventionally, ages are represented through discrete integer values, even if, from a theoretical (and highly impractical) point of view, they should be a continuous range of numeric values. Concerning the number of values that a given object can assume on this axis, this is an example of multi-value dimension.
2. *Target grade*: This axis lists the stages of education where learning materials are meant to be taught. It can be represented through an enumeration

including pre-school, primary school, middle school, secondary school, higher education, continuing education, etc. Values in the enumeration can be customized depending on the educational system in use, and usually they present a natural sorting based on the sequence of educational stages. Since the same material could be profitably used in different learning contexts, a learning object can take multiple values on this axis.

3. *End users*: When focussing on music-related learning materials, the intended audience can embrace different categories of users, and the definition itself of such categories is strongly subjective: generic students vs. music learners, untrained people vs. amateur practitioners vs. professional musicians, etc. In this case, a single dimension can generate multiple axes, where each axis can be seen as an unsorted and customizable enumeration allowing multiple values.
4. *Formal/informal music learning*: This axis investigates the eligibility of the material under observation within a formal music institution (music high schools, music academies, conservatories, etc.) or, rather, in a different learning environment, e.g., a general-purpose school or a non-formal/informal learning environment, not having the concepts of curriculum, syllabus, accreditation, and certification typically associated with formal learning. In this case, a multiple-choice enumeration seems to be the most suitable solution.
5. Required *level of music knowledge*: Strictly related to the previous dimension, we can represent on a dedicated axis the level of previous music knowledge expected from target users. Such an aspect could be easily represented on a numeric scale, where, e.g., 0 means no previous knowledge, and 10 indicates professional musicians.
6. *Pedagogical goals*: As it regards music learning, pedagogical activities include listening, theory, performance abilities, creation, production, analysis, and so on. A formalization well accepted in literature organizes those activities in three groups: creation, performance, and response.[3] The pedagogical goals play a key role in scaffolding digital learning materials. The corresponding axis potentially supports multiple values from a customizable and multi-layer enumeration.
7. *Foundational pedagogical theories*: The goals detected above can be achieved through different pedagogical approaches, including Jean Piaget's (1964) theory of cognitive development, Howard Gardner's (1992) theory of multiple intelligences, and many others. This axis potentially supports multiple values in an enumeration.
8. *Methods for music education*: This axis considers the pedagogical methods specific to music education, e.g., Dalcroze method, Kodály method, Orff Schulwerk, Suzuki method, and Gordon's Music Learning Theory. In the context of smart pedagogy, it is necessary to explore the relationship between these traditional approaches and new technologies.

9. *Technologies*: Learning materials can be conceived to be experienced through different digital technologies, e.g., desktop applications, web interfaces, augmented and virtual reality, multimodal interactive environments (Kinect, Leap Motion, tangibles, etc).
10. *Response to special needs, response to physical/cognitive impairment*: These parameters can be evaluated either globally or focussing on specific aspects (e.g., usability for blind or deaf people, support for dyslexic users, etc.). Even narrowing the field of investigation to a single aspect, there are multiple ways to scaffold learning materials on this axis: a simple yes/no answer (e.g, is it suitable for blind people?), a continuous numeric scale (e.g., to what extent quadriplegic users can use it?), or a multiple-value enumeration (e.g., in an aggregated axis for learning disabilities, is it suitable for dysgraphia, attention deficit hyperactivity disorder, auditory processing disorder, developmental coordination disorder?).

In addition to the mentioned aspects, we can consider a number of dimensions referring to practical issues: How much does the didactic material, or the learning platform, cost? In case of computer-based tools, are they multi-platform or do they present specific software/hardware requirements? Is pedagogical quality certified by an institution?

Finally, user-tailored questions as well as specific knowledge of a domain expert can greatly increase the number of dimensions. For instance, Leman (2007) presents an interesting classification of applications using the categories of *mediators* (intended as tools) and *facilitators* (namely strategies to simplify the solution of a problem). A scholar interested in this kind of approach could identify an additional axis scaffolding the functions for digital materials in terms of mediators or facilitators.

After determining a suitable collection of axes and their domain, the classification of a learning object emerges as a given set of values for each of the considered dimensions.

Towards a multidimensional taxonomy

The partial list presented above remarks the need for educators to understand and evaluate the heterogeneity of parameters characterizing learning materials. In our opinion, only a global and comprehensive analysis can bring to a conscious choice and, consequently, to an optimal selection for a given educational context.

Didactic materials that are effective in pre-school music teaching will presumably prove unsuitable in a higher education music institution. Similarly, materials adopting cutting-edge technologies (e.g., augmented reality) or gamification approaches could be the best solution to bring young people closer to music and catch their attention, but they could cost too much for a public-school budget. In other terms, there is no general solution capable of optimizing scores in all axes; rather, educators are invited to explore the multidimensional space, analyze the solutions that best fit their needs along different axes, and compare materials belonging to the same cluster.

In our vision, the multidimensional space itself should not be considered as a fixed reference where all conceivable music-learning materials can be classified, but, rather, as a reference guide to gain awareness about the non-trivial problem of scaffolding. Under this perspective, flexibility is a key aspect that finds multiple applications. First, users can customize the multidimensional space depending on their needs and expectations. Secondly, they can join their efforts to define a commonly-accepted taxonomy that can act as a shared platform to cooperate in a crowd-based environment.

Providing an effective graphical representation of a multidimensional space is not trivial when the dimensions involved are more than three. From this point of view, a computer-based tool can help by automatically providing suitable representations and supporting filters and insights for specific dimensions.

An example of classification

In this section we propose a possible classification of learning materials over the multidimensional taxonomy previously discussed. The goal is to unveil the potential of this tool in selecting smart learning objects for a specific educational context, tailored to fit the teacher's needs.

Defining axes

The first step is the definition of axes, which is mostly a subjective operation. This step can be subdivided into two sub-tasks:

1. The choice of the dimensions suitable to catch the features considered as relevant by the teacher. For example, an educator, when planning their lesson, could be more interested in the target age than in the grade of students, and they could deliberately ignore their previous music knowledge;
2. The type and interval of values that each axis contains.

With respect to the latter point, the discussion in section 'A multidimensional taxonomy' highlights that such an operation is not trivial. Often, numeric axes are self-explanatory, as in the case of the *Target age*. Please note that, even in this simple example, some aspects are left to subjective choices, concerning, e.g., the granularity adopted to measure students' age (years, months, etc.).

The detection of meaningful values for enumerations is more challenging, and it can have a deep impact on the global classification task. In several cases, there are normative references that can help in the choice. For instance, the stages of compulsory education that populate the *Target grade* axis may change from country to country, but they are clearly defined within a given national system.

Conversely, some decisions about non-standard enumerations are necessarily subjective. Nonetheless, the process can take benefit from literature-based guidelines. As a clarifying example, we focus on one of the axes of the taxonomy, namely that of *pedagogical goals*, which we consider as being both relevant in most applications of the taxonomy and helpful in order to gain an initial picture of the related literature. The idea to populate such an axis is to conduct a systematic review of the scientific literature on technology-enhanced music education, following the general framework and the taxonomy presented above.

In this sense, some relevant previous works on ICT and music education help structuring our own survey. One of the earliest contributions is due to Crow (2006), who focusses mostly on technologies and resources available at the time, such as recording and monitoring, electronic keyboards, MIDI, Internet, and CDRoms. On the other hand, Rudolph (2004) tries to establish a connection between technologies and pedagogical goals. Specifically, he refers to the conceptual framework elaborated by the National Center for Education Statistics in the United States, for the assessment of education in the arts (Persky, Sandene, & Askew, 1997), which in turn defines a set of ‘artistic processes’: creating, performing/producing/presenting, responding. These processes define and organize the link between the art and the learner. They are cognitive and physical actions by which arts learning and making are realized, and each art discipline incorporates these processes in some way.

Some similarities may be found in the work of Webster (2007), who refers to the areas of ‘composition’ and ‘performance’, plus a set of more theoretical and analytical areas (ear training, analysis, etc.). Brown (2007) identifies a set of somewhat wider areas related to ‘presentation’ (including performance), ‘production’ (including composition), and ‘reflection’. Additionally, he provides an interesting categorization of the role of computers in music education: specifically, the computer can be a tool, a medium, or a musical instrument, and these functions map onto several application areas. Unlike the previous authors, Watson (2011) focusses on the domain of creation only, and identifies various areas where technologies can help musical creativity. Finally, in a recent work Bauer (2014) proposes a conceptual framework for technology-assisted music learning, in which the three domains ‘creating’, ‘performing’, and ‘responding’ are mentioned in the title already. These domains are embedded into a general model for teaching and learning with technology, called Technological Pedagogical and Content Knowledge (TPACK), originally proposed by Mishra and Koehler (2006). According to this model, today’s teachers must be equipped not only with content and pedagogical knowledge, but also with technological knowledge. The underlying assumption is that, being able to use technology effectively requires not only an understanding of technology itself, but also of effective pedagogical approaches for utilizing that technology in a particular content area.

From this analysis we conclude that the three labels *creating*, *performing*, and *responding* provide a robust first-level categorization for the pedagogical domains of technology-assisted music education. With reference to the previous discussion on the development of a multidimensional taxonomy, we can state that the axis of *pedagogical goals* and these three labels are reasonably time- and context-invariant, as they apply to several educational systems and music cultures (indeed, they even apply to education in arts other than music).

Figure 5.1 shows a tree of labels that include a further level, i.e., specific subdomains. We propose these based on an ongoing analysis of the scientific literature, which shows that technology-enhanced educational tools have been proposed for all of them. The domain concerned with *creating* includes composition (Freedman, 2013), improvisation as a related but different subject (Fein, 2017), programming (Manzo, 2016), and production (Dillon, 2003). The domain related to *performing* can be subdivided into conducting (Bevilacqua, Guédy, Schnell, Fléty, & Leroy, 2007), reading skills (Chou & Chu, 2017), playing and accompanying skill (Burns, Bel, & Traube, 2017). Finally, the domain labelled as *responding* is concerned with more theoretical subjects, including analysis (Brown, 1999), music theory (Phon-Amnuaisuk & Siong, 2008), aural skills (Quesnel, 2002), active listening (Addessi & Pachet, 2005), music appreciation (Piccioni, 2003), and musical games (Gower & McDowall, 2012).

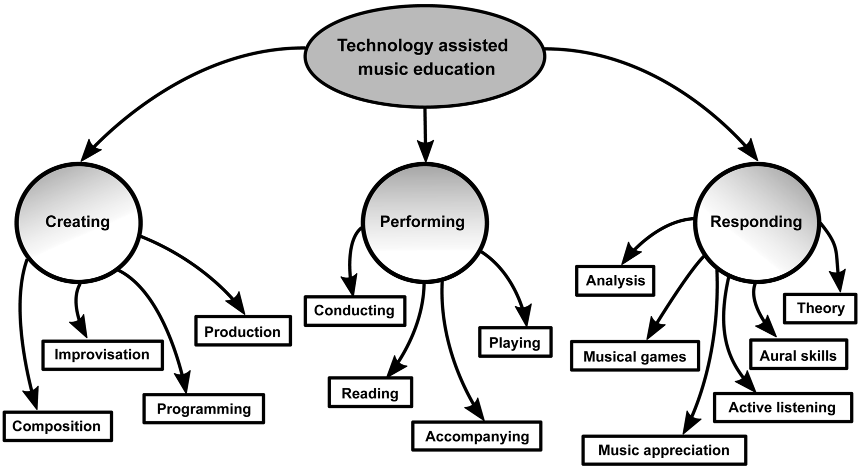

Figure 5.1 The multi-level graphical representation of the pedagogical goals axis emerging from our literature review.

Placing smart learning objects

After conveniently defining the axes of the taxonomy, the second step consists of placing smart learning objects into the multidimensional space. Let us mention three practical examples, starting from some relevant technologies introduced in section 'Technological advances for music education'.

First example is a music game to foster computational thinking in young students (Baratè et al., 2017), focussing on the description of musical information through the use of a programming language. Based on the visual programming platform Google Blockly[4], the game aims at reconstructing music tunes through the combination of various music operators, each acting in the boundaries of well-defined musical concepts (e.g., melody and rhythm) and structures (e.g., iteration and lists of music events). The game is intended for generic students of primary and middle school with no formal music education. However, previous knowledge may provide learners with basic concepts, which can help them in understanding the potential of the game. The pedagogical goals are both *creating* and *responding*, since each action on the music material requires an evaluation process from the children who may decide for acceptance or rejection. The constructivist learning theory, which states that children themselves are the builders of their own knowledge (Harel & Papert, 1991), is fully supported in this kind of activity where young learners are free to explore and evaluate the various possibilities offered by the game.

A further example is provided by two serious games (Baratè et al., 2013): *iClef* and *[Score] Following Puccini*. *iClef* is a serious game for training music reading abilities in different clefs. *[Score] Following Puccini* exploits the possibilities of the multilayer format IEEE 1599 (Baratè & Ludovico, 2012), which can synchronize various music information layers (performance, notation, audio, and other metadata) through XML (Bray, Paoli, Sperberg-McQueen, Maler, & Yergeau, 2000). Thus, a music student can listen to a score, switch among the various revisions, transcriptions, and performances of the same piece, see its structure (form, musical phrases, harmony, etc.), and study its orchestration. For such serious games based on music notation, the target age is rather high as the users are required to have good academic musical knowledge. The pedagogical goal falls into the *Responding* domain for both applications. In the case of *iClef*, the user has to deliver the note names at an increasing speed as soon as the system displays their graphical representation. Conversely, *[Score] Following Puccini* asks the user to interact with the complexity of the various musical layers, experimenting with different listening and score following modes. The pedagogical theory involved refers to the theory of multiple intelligences (Gardner, 1992). In the case of *iClef*, the visuo-spatial intelligence is used for recognizing notes and intervals on the staff, while musical-rhythmic and verbal-linguistic abilities are required in the experience of score following.

Table 5.1 The values assumed by three heterogeneous learning objects on the axes of a custom multidimensional taxonomy

	Learning objects		
Axes	*Music game*	*Multi-layer encoding*	*3D-printed music notation*
Target age (years)	[6,14]	[14,+∞]	[4,11]
Target grade	Primary and middle school	From secondary school on	Preschool and primary school
End users	Generic students	Music learners	Generic students
Formal music education	Not required	Yes	Not required
Previous music knowledge	Required	Required	Not required
Pedagogical goals	Creating, responding	Responding	Creating
Pedagogical theories	Constructionism	Multiple intelligences	Constructionism
Technologies	Coding, web	XML, web	3D printing

A final example deals with music notation and 3D-printed construction blocks (Avanzini, Baratè, & Ludovico, 2019). Bricks can be retrieved from already available construction sets or autonomously fabricated by children. They may have different colours, shapes, thickness, and surface roughness, and such characteristics may be associated with musical qualities. As a result, multiple senses are potentially involved in the creative process. This kind of applications is intended for very young children, without any previous formal or informal musical knowledge. Again, constructionism plays a fundamental role in these experiences because children are fully engaged in the creative environment without constraints other than their own ideas and curiosity.

The results of the analysis of the three practical examples are summarized in Table 5.1.

Navigating the point cloud

This is the last step that comes after the placement of smart learning objects in the multidimensional space, and requires a critical analysis in order to select those materials that best fit educational needs. The resulting point cloud can be observed from different perspectives, e.g., to discover identities or similarities (i.e., learning objects whose values along different axes are identical or very close), or to introduce heterogeneity along one dimension while values on other axes are equal.

This step introduces the problem of metrics, namely a quantitative assessment used for comparing elements. While a condition of identity, in one or multiple dimensions, is easy to detect, measuring the distance between elements is meaningful only in some cases. For instance, concerning the target grade, it is commonly accepted that preschool is ‘close’ to primary school; thus, a learning object suitable for preschool children is likely to also fit primary school students. In other cases, and particularly for dichotomous choices, measuring distances does not make sense.

Conclusion and future work

In this chapter we have presented a theoretical framework aiming at scaffolding smart learning objects for music education. Starting from an analysis of the scientific literature and from the state of the art about technologies for music, we have identified a multidimensional taxonomy as the most suitable tool. A key characteristic is the possibility to customize the definition of the axes, concerning their goal, number, and value type.

The multidimensional representation itself strives to be smart. In fact, a computer-based implementation of the approach may support the following smart features:

- After defining a set of rules, digital objects can be automatically placed, thus originating the corresponding point cloud;
- Meaningful metrics can be automatically computed in order to detect identical or similar learning objects;
- Smart filters can be implemented, in order to guide the teacher’s selection of best materials;
- The graphical representation of the taxonomy can be rendered and filtered according to the user’s needs.

In the near future, we are planning to release a computer-based collaborative tool in order to test the applicability of our theoretical framework.

Notes

1. IEEE stands for Institute of Electrical and Electronic Engineers.
2. ACM stands for Association for Computing Machinery.
3. See, e.g., https://nafme.org/overview-of-2014-music-standards/
4. https://developers.google.com/blockly/

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