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Quantitative Approaches to the Pedagogy of Music-Making

A Discourse From the Perspective of Educational Research

Quantitative Ansätze zur Musizierpädagogik

Ein Diskurs aus Perspektive der Bildungsforschung

Patrizia Bieber, Bret P. Smith & Richard Göllner

Abstract

The present work focuses on quantitative empirical research approaches to issues of the pedagogy of music-making and examines these from the perspective of current educational research. Against the backdrop of specific challenges in music education, the question of what significance music-making and its teaching should have in today's educational landscape and what prerequisites need to be created for this from a research methodological perspective is explored. Current and prospective developments in the field are discussed to provide clear recommendations for future research on issues of the pedagogy of music-making in the context of empirical educational research. In particular, large-scale assessments, longitudinal studies, and intervention studies are addressed.

Zusammenfassung

Die vorliegende Arbeit befasst sich mit quantitativen empirischen Forschungszugängen zu musizierpädagogischen Fragestellungen und beleuchtet diese aus Sicht der aktuellen Bildungs-

forschung. Vor dem Hintergrund spezifischer Herausforderungen in der musikalischen Bildung wird der Frage nachgegangen, welchen Stellenwert das Musizieren und dessen Vermittlung in unserer heutigen Bildungslandschaft einnehmen sollten und welche Voraussetzungen dafür aus forschungsmethodischer Sicht geschaffen werden müssen. Diskutiert werden aktuelle und prospektive Entwicklungen des Feldes, um schließlich klare Handlungsempfehlungen für die künftige Beforschung musizierpädagogischer Fragestellungen im Kontext der Empirischen Bildungsforschung bereitzustellen. Eingegangen wird dabei insbesondere auf Large-Scale-Assessments, Längsschnittstudien und Interventionsstudien.

1. Music-making as part of general education

> „ἐκ μὲν οὖν τούτων φανερὸν ὅτι δύναται ποιόν τι τὸ τῆς ψυχῆς ἦθος ἡ μουσικὴ παρασκευάζειν, εἰ δὲ τοῦτο δύναται ποιεῖν, δῆλον ὅτι προσακτέον καὶ παιδευτέον ἐν αὐτῇ τοὺς νέους."
>
> "[M]usic has the power of producing a certain effect on the moral character of the soul, and if it has the power to do this, it is clear that the young must be directed to music and must be educated in it" (Aristotle, 1944, Politics. Book 8. 1340b).

In ancient times, music, as one of the seven liberal arts, was considered an integral part of a comprehensive human education that fully develops personality and socially desirable character traits. Moreover, the ability to perceive and produce rhythm and melodies is closely linked to human evolution, as emphasized by Charles Darwin (1871). Producing sounds and rhythm, in turn, is directly linked to the acquisition of language skills as well as mathematical competencies since creating rhythm means organizing sound events within specific time intervals (Geist & Geist, 2008; Moritz et al., 2013). This inevitably connects music with questions of education and learning. Former uses of the numerical alphabet in composing music (e.g. gematria in J. S. Bach's work) or physical properties of sound production (frequency ratios, overtone spectrum, etc.) strongly support this connection. Music-making, in addition, appeals to three of our basic perceptual abilities – auditory, visual, and haptic – and therefore activates the same channels of our sensory organs we need for learning, communicating, and interacting with our environment. Accordingly, making and understanding music is particularly linked to our understanding of the world and the general development and growing up of human beings. Against this background, it seems sensible to consider music-making in the context of education and there are several reasons to justify its position in it historically (Walker, 2007), which leads to the conclusion that educational research should also pay special attention to it. However, today's discussions about education rarely involve music-making and in the context of empirical educational research music is hardly considered (e.g., Barz & Liebenwein, 2018; Reinders et al., 2015). For what purpose, with what consequences, and how this could be changed are the central topics of this paper. We examine these topics from the perspective of active musicians, music educators and at the same time scientists who are themselves active in the research field of the pedagogy of music-making.

Starting from the premise that music-making should be part of general education, two big questions arise: First, how should music-making be positioned in the general educational context, and to what end might it be worthwhile to strengthen it as an essential part of general

education? And following on from this question, what is needed (or needs clarification) to give music-making a justified position in today's education?

By refering to music-making as an unique human activity, we do not want to narrow the pedagogical view to curricular or extra-curricular musical learning environments in which music-making takes place, but rather consciousy consider all areas of music-making in the context of formal education and bring them together under a common denominator. The present article is therefore explicitly about the practical activity of making music as educational content, which can take place in individual, group or class lessons.

Thinking about music's position in today's education systems, we are confronted with two points of view that seem to divide "educators, administrators, artists, and parents […] in their advocacy for music's essential role in public education" (Scripp, 2002, p. 132): One side advocates music to be an independent discipline that should be taught for its own sake, and the other side believes in music as a necessary experience for everyone that interacts with other subject areas and should be deliberately combined with other learning content. Lawrence Scripp (2002) refers to the two fractions as "essentialists" and "instrumentalists" and suggests that the divide between them might be one reason why policymakers are often reluctant to promote musical education and give it the status of a core subject at school. Wayne D. Bowman (2018) deals with these two perspectives similarly. He differentiates between "music training" and "music education" (p. 21/22) to draw attention to the fact that music can be either taught by pursuing concrete aims like gaining expertise in common musical practices, or it can be taught as a universal experience that prepares people for life in general, i.e. to support open-ended learning processes. Therefore, a clear distinction between educating *in* and educating *through* music should be made (Bowman, 2018, p. 29), as Anne Bamford (2006) also suggests by investigating the whole arts context and differenciating between education *in* and education *through* the arts (p. 11).

We certainly agree that it is necessary and imperative to provide both options – educating *in* and educating *through* music. However, in the context of a general education that is available to all people and that shapes society, Bowman's so-called "music education" – i.e. supporting individual growth and development *through* music (Bowman, 2018) – seems to demand special consideration in view of its content orientation. The necessity of this demand based on Bowman's political and advocacy intention can be supported with regard to gaining aesthetic experiences and the perception of cultural capital (Bourdieu, 2012; Lareau & Weininger, 2003) which was expressed by Jerrold Ross (1994) and became apparent in the study of Alexandra Lamont and Karl Maton (2008). The latter study showed that with rising class levels music is increasingly perceived as very elitist among students, since, in contrast to other subjects, achievement in music depends not only on knowledge but also on personal dispositions the individual may not possess or believe in. This observed perception, that also underlines the weight of the practical component of the school subject, is accompanied by a decline in the perceived importance of music as a school subject in higher grades close to the British GCSE level. Similar problems with low student motivation and their correspondingly low valuing of music at school are described by Mikko Anttila (2010) and Gary McPherson and Susan O'Neill (2010). We should be aware that "the conditions required by [musical] training may be inimical

to our broader commitments to educate through music, commitments on which our claim to a prominent role in general education must be based. Musical training is not synonymous with musical education, nor is it an acceptable substitute for musical instruction devoted to broadly educational aims" (Bowman, 2018, p. 31). In line with this, we suggest that we should clearly differentiate between broad-based and top-level promotion in the field of music and adopt a more process-oriented approach instead of a product-oriented one to make it more socially accessible. So, if music should be able to take its place in general education again, it must lose its elite status and be better embedded in the overall understanding of education and its goals.

Addressing music-making in particular, the gap between training and education may be even greater since music-making covers a broad spectrum, ranging from basic class music-making and extracurricular music-making in the amateur sector up to gaining high expertise and playing an instrument or singing at a professional level. To give music-making a chance to contribute to general education we must therefore follow the approach of the "instrumentalists", letting education through music-making deliberately interact with different learning content and accordingly keep in mind that we do not aim at reaching high musical and technical expertise. The goal, rather, is to foster humans' growth and development holistically, enabling people to engage in individual experiences that help them find their path in life, develop their personality, and realize themselves as well as to develop critical thinking and an understanding of culture (Ross, 1994; Walker, 2007).

For this purpose, however, the goals of general education should be clearly defined so that music-making can be positioned as an essential part of it. On the one hand, the current international understanding of education is largely determined by the concept of literacy – a basic education for everyone, which not only means teaching basic writing and reading skills, but rather creating the conditions to "enabl[e] individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society" (UNESCO Institute for Statistics, 2024, Definition section; Bieber et al., 2025). On the other hand, as today's world is very performance-oriented and committed to concrete aims, general education seems to lack real "general" goals that prepare people for daily life and give them tools to cope with life's challenges (Tateo, 2018). Bowman (2018) also underlines that the objectives of education today are unclear as society tends to move toward ambitious training goals that contradict general educational goals.

In this context, it seems quite difficult to reconcile music-making with general education and hit its target. This development of our contemporary education systems might have even contributed to the fact that music has lost its universal position in education, because "music instructional practices have followed suit: the life-enhancing skills and capacities a musical education seeks to serve have been replaced by the rules, formulas, sequences, and prescriptions of instructional method. In gravitating toward these, music instruction has unwittingly come to neglect the educational ends it is especially well suited to address" (Bowman, 2018, p. 34). Various authors have observed the development discussed and describe a clear downgrading of the artistic subjects' importance and music education as part of the compulsory learning content at school (e.g., Aróstegui, 2016; Kratus, 2007; Liebau, 2018). Under this consideration, we first have to find a consensus on what general education means and what it should look like, in order

to align music-making with it (Bowman, 2018; Ross, 1994). This challenge, however, can be also seen as a chance for music-making to raise debates about basic educational objectives. Being aware of its inherent potential and unique selling points, music-making can also actively contribute to shaping today's education and demonstrate its benefits for it – guiding our educational system in the direction that follows the approach of the ancient age which could hold profitable contributions to enhancing present and future society's overall nature and well-being (Bitros & Karayiannis, 2009; Sahibzada et al., 2015).

This inevitably leads to the second question of what is needed to give music-making the position in today's education that seems appropriate to us, and already partly answers it. If we want to align music-making with general educational goals, we have to demonstrate its beneficial potential and be able to use and at the same time handle the "intricate balance between its 'special' status or distinctness and its discernible contribution to educational goals" (Bowman, 2018, p. 32/33). And that brings us to the point: This is where research must start.

In the spirit of the basic scientific endeavor to better understand the world in its contexts, research should aim to contribute to defining music educational approaches that enrich our society, show how music-making can profitably be used in education, and how it can be connected to other learning areas. Christopher Johnson (2018) even states that it is the research's task and necessity to define the profession of music education and its place in practice. Putting the onus on research and demanding solid research findings may therefore be a promising way to re-locate music in education today and legitimize its place in the eyes of policymakers. Ultimately, if the pedagogy of music-making is to be included as a fundamental part of our current general education, the "music education community", which includes practitioners, teachers, and researchers alike, must actively engage in ongoing educational discussions, articulate music-making's stance and potential contributions to contemporary education, and intentionally collaborate and interact with other fields of learning. Along with this claim, research on the pedagogy of music-making must join educational research, which goes hand in hand with certain demands. It has to address the same challenges as educational research, follow the same goals, and pursue the same standards (Ross, 1994). So, it is important to consider the question of what constitutes educational research and accordingly ask, how music-making fits in and how it can be reconciled with it. This work, therefore, will consider ongoing research on issues of the pedagogy of music-making, discuss its designs and methodological approaches, as well as discuss further directions and perspectives.

2. Quantitative educational research and the pedagogy of music-making

Quantitative educational research defines itself as research that is intended to provide knowledge highly relevant for practice, and to describe, explain, and steadily help to improve both knowledge and practice (Gräsel, 2011; Tippelt & Schmidt-Hertha, 2018). The focus is on the desire to understand learning and educational processes, whereby research is not limited to the cognitive level, but also aims to understand the interplay with motivational, emotional, or

volitional dimensions. The entire learning environment, including social constellations, is taken into account, and development over time is of particular interest (Maag Merki, 2021). Therefore, quantitative educational research follows the following standards that mainly stem from the standards of the empirical social sciences: a) it tackles questions or problems that are found in practice, b) it is evidence-based, c) it is eclectically underpinned, i.e. is based on a solid theoretical base or takes up existing theories, d) it expects well thought-out designs, and appropriate, rigorously documented procedures including the methods and analysis used, e) it follows the claim of generalization, i.e. conclusions about the total population are inferred from a chosen sample (Anderson & Arsenault, 1998; Gräsel, 2011; Reinders & Ditton, 2011).

Educational research attaches great importance to being trustworthy to ensure applicability in practice or to provide the field with fundamental insights, which goes along with high-quality standards in terms of methodologically well-trained researchers as well as constant critical reflections and continuous exchange (Gräsel, 2011; Reinders et al., 2015). This includes being aware that evidence is not neutral and requires deep methodological understanding, complex analysis, and corresponding interpretation of results to make evidence-based decisions (Ardila-Mantilla, 2018; Teo, 2013). Continuous and critical exchange must be ensured by regular interdisciplinary meetings among researchers, fruitful collaborations, and openness and willingness to share ideas with the practice. This has so far seemed less the case with music-making in the field of educational research, as preceding conference volumes (e.g. from the NASFA or AERA annual conferences) reflect. Although individual efforts and endeavors exist, music-making still played a very subordinate role at international education conferences, and was hardly a topic regarding the research content discussed. Taking the AERA annual conference as an example, in each of the last five years (2020–2024) there have only been one to five presentations or poster contributions in the conference program refering to "music-making", "music making" or "making music", out of an immense total number of sessions, which exceeded 2,500 last year. A change in this situation should profitably increase the interdisciplinary exchange and the visibility of music-making and its teaching in the international field of educational research.

Furthermore, research on education has gotten more sophisticated as our world is constantly changing and human knowledge is growing and becoming more complex (Hartas, 2015; Teo, 2013). Dimitra Hartas (2015) describes that "[e]ducational research is transdisciplinary and strives to capture the complexity of educating and learning, and elucidate the link between current pedagogy and tomorrow's citizens" (p. 14), which is why researchers should not focus so much on the past and the present, but rather keep an eye on the future. This results in the challenge of understanding various levels and interactions between different influencing factors of our world today, which explains why multi-level models are in vogue given their usefulness with regard to analysis of complex systems (Reinders, 2011). The complexity of learning an instrument or singing, i.e. acquiring motor, cognitive as well as musical-emotional skills can be immense. In combination with different learning environments and places of music-making, such as single or group lessons, practicing at home, and playing together in chamber music formations or larger ensembles like an orchestra, the complexity becomes even greater. Additionally, all music instruction is not created equal, and discerning more- or less-effective

approaches to achieve learning goals has long been a focus of music educational research. Research on the pedagogy of music-making is accordingly confronted with an array of different variables whose span can be very large. To grasp this huge amount of information, organize it, and draw sense out of it, quantitative statistics can help. Or to go even further – it is precisely (and perhaps only) quantitative statistics that can solve such problems. If we do not progress here and approach this high complexity we are confronted with, we will fail to explain and understand phenomena that may be crucial for the further development of our field (Miksza & Elpus, 2018).

Whereas exchange with the practice and practical relevance might be less of a problem in the field of the pedagogy of music-making, as many of the researchers come from the artistic-practical field or are still working in it, the high methodological standards and statistical sophistication may be challenging at times, and initially daunting for lateral entrants. However, quantitative empirical research and its well-established procedures can contribute to achieving a more systematic perspective on musical education and meanwhile, many good handbooks exist to help both the novice and experienced researcher (e.g., Asmus & Radocy, 2006; Miksza & Elpus, 2018; Russell, 2018). So, speaking from the inside perspective of scientists working in this field of research, we should not fear this topic but rather be pleased if the research on the pedagogy of music-making can break new ground in this respect. This will also help us to grasp the enormous amount of experiential knowledge that exists in our field, gained from daily life but not yet scientifically underpinned (Schulten & Lothwesen, 2017).

3. Challenges facing research on music-making

In addition to the general challenges facing education today, such as the problems arising from globalization, diversity, digitalization, and the changing age structure of society, the pedagogy of music-making has to deal with specific challenges:

1. Music-making's value as a subject or content area, as well as its place in general education, differ from culture to culture and country to country. Its role in the school's context is just as unclear as its role as an extracurricular activity. Questions of who is responsible for it and who should offer it have not been clarified in many places. Moreover, constant changes in life circumstances, like the increase in full-time working parents, require new, adaptable, and sustainable concepts. This involves also questions about limited access to cultural education that arise outside of school.
2. Music-making is built on enculturation and therefore always involves questions of social and historical imprinting, taste, and habituation. A wealth of different forms of music-making exists, and in addition, there are always personal preferences.
3. Changing social structures are changing the areas in which music-making is used. For example, music therapy could become more influential due to the increasing awareness of mental illnesses, just as the aging of society calls for attention to geragogics and issues of lifelong learning.

4. As mentioned at the beginning, it is not yet clear how music-making can contribute to today's educational goals, i.e. what transfer effects music-making can really have and where the greatest potential of music-making lies. For example, challenges of decreasing school performance and learning difficulties in children might be compensated for with artistic-musical activities. The pedagogy of music-making must therefore keep an eye on the development of other subjects and take a holistic view of our educational system. In line with this, it is emphasized that the interdisciplinary contexts of music education and music-making are far-reaching, including, among others, psychology, sociology, educational sciences, ethnomusicology, and cultural sciences (Dartsch et al., 2018; Jorgensen, 2009).

Apart from the challenges described on the level of purpose and content orientation, there are others on the scientific and, in particular, methodological levels that need to be taken into account when thinking about research on issues of the pedagogy of music-making.

1. As music-making environments can be individually chosen and often involve selective groups, recruitment of appropriate sample sizes can be problematic (Busch, 2018). Additionally, true random sampling or random assignment, as required by experimental designs, is very difficult if not impossible to achieve. Researchers should therefore strive for good cooperation with organizations and associations of music education to expand research possibilities at the organizational level and to simplify data collection, as well as be skilled in employing multi-level analytic procedures such as multilevel models (Miksza & Elpus, 2018).
2. There are still several myths about the benefits of music-making and the conception of "talent" as a prerequisite for musical skill acquisition in general (Düvel et al., 2017; Müllensiefen & Harrison, 2020; Scripp et al., 2013; Sloboda, 1996). Certain widespread beliefs about the positive transfer effects of music-making are based on misinterpretations of causality, i.e. they rely on studies that showed important associations between music-making and target outcomes on the learner's side but were unable to make any statements about causal directions. So, there is still the need to correct false assumptions, or rather provide the field with research that is suitable for reporting causal effects. Furthermore, the discussion should urgently continue around the question of which transfer effects we should focus on and whether the emphasis should perhaps not be on social-emotional issues. Significant reviews and meta-analyses published in recent years underline this and illustrate the complexity of the ongoing discussion on transfer effects (Bamford, 2006; Román-Caballero et al., 2022; Sala & Gobet, 2020; Schellenberg & Lima, 2024).
3. Terminologies in the context of music education as well as research priorities vary greatly depending on the country (Kraemer & Schlegel, 1999). Good insights into country specifics are provided in the papers "Mapping music education in…", published in the journal *Psychology of Music* (Cheung, 2004; Hentschke & Martínez, 2004; Jÿrgensen, 2004; Price, 2004; Stevens & McPherson, 2004; Welch et al., 2004).
4. Both investigated populations and research designs applied in research on music-making vary greatly (Ilari, 2020), which on the one hand reflects the breadth of the

research field and its diversity. On the other hand, however, this variety leads to an unmanageable field of stand-alone projects that can neither be summarized nor compared.

5. The human ability of music-making encompasses an immense spectrum of different competencies, ranging from motor to sensory, and intellectual to musical abilities, whereby it is the coordination and interplay of the multiple facets that form the complete mosaic. And how this mosaic affects others can be very subjective and emotional. Therefore, defining music-making competencies and assessing them presents a major challenge for research on issues of the pedagogy of music-making.

4. Resulting needs

To tackle the above challenges and at the same time aim for high-profile studies to make the "music education community" heard and convince policymakers as well as the general population of the importance of music-making in the educational context, we will now discuss four common research approaches from quantitative empirical educational research that we consider essential for research on the pedagogy of music-making.

4.1 Assessment instruments

As mentioned earlier, assessing musical and technical competencies in playing instruments or singing poses a significant challenge due to their inherent nature. Above all, musicality is something intuitively human, closely related to human feelings, and therefore difficult to grasp objectively. In this context, there are two major issues that form seemingly unsolvable questions: 1. What constitutes musicality? Which individual components can be distinguished, how do they interact, or is there an underlying gerenal musicality factor (Bieber, 2025; Müllensiefen & Hemming, 2018; Pausch et al., 2021)? 2. When applying tests, are we measuring abilites that have developed naturally from genes and in interaction with the environment, or rather skills that have been consciously trained (Bieber, 2025; Gagné, 2015; Sloboda, Davidson, & Howe, 1994)? This basis was certainly one of the main reasons few suitable assessment tools have been available for a long time, let alone that many have been established and used in several studies. Critics pointed out in particular that the existing tests are 'atomistic' and use artificial stimuli that miss the real essence of music (Müllensiefen, 2019). So, researchers commonly developed their own measures in dissertations and studies, and accordingly, relatively few replications and validity or reliability analyses exist. Concerning the school's context, John M. Denis (2018) also stated that no consistency in assessments could be reached so far because the goals of teaching music are not clear and assessment approaches therefore differ widely.

While these measurement challenges remain, the research literature documents numerous projects over five decades that focus on the development and validation of rating scales to be applied to musical performance (e.g., Abeles, 1973; Cooksey, 1977; Smith & Barnes, 2007; Zdzinski & Barnes, 2002). These scales seek strong inter-rater reliability and identification of

key performance dimensions using a factor-analytic method. The *Primary, Intermediate,* and *Advanced Measures of Music Audiation* of Edwin E. Gordon (1986, 1989) remain one of the only test batteries designed to measure foundational rhythmic and melodic discrimination skills with published norms by school grade level. These measures continue to attract interest and analysis from a psychometric perspective (Platz et al., 2022).

Over the last few years, there have been advances and single projects were able to develop urgently needed assessment tools to capture individual differences in musical sophistication, perceptions, and abilities such as the Gold-MSI (Müllensiefen, 2019), the LongGold Test Battery (*LongGold Battery Demo*, n.d.), or the PROMS (Law & Zentner, 2012). Adaptive tests are, following on from this, on the way (Harrison et al., 2017; Labonde & Müllensiefen, 2022) which enable faster and more precise testing.

Given the need for high-quality measures as a central component of any quantitative research in music learning and its effects, this development of test batteries and the prospect of a well-proved repertoire of available assessment tools should be pursued further. It forms the basis for all the research approaches discussed below and will enable the comparability of research results. A noteworthy approach to this was taken by the German Society for Music Psychology (DGM), for example, in the provision of its Online Testing Server (Deutsche Gesellschaft für Musikpsychologie, n.d.).

4.2 Large-scale assessments (LSA)

Large-scale assessments (LSAs) are cross-sectional studies with large, representative samples conceived to depict the overall picture of a population. In educational research, they are especially used to describe the acquired competencies and academic achievement of a specific population to afterward enable comparisons at the system level, e.g. between different countries or school systems. In most cases, *Item Response Theory* (IRT) models are applied to measure the variables of interest and deal with manifest and latent variables when assessing competencies (Hasselhorn & Hasselhorn, 2017; Nagengast & Rose, 2018).

Considering the contexts and frequency in which LSAs have been carried out in recent years, there have been individual advances with large-scale studies addressing primarily health aspects of music-making (e.g., Ekholm et al., 2016; Gembris et al., 2018), or investigating musical abilities such as rhythm skills or music perception from a biological-evolutionary perspective (e.g., Anglada-Tort et al., 2023; Jacoby et al., 2024; Niarchou et al., 2022). Apart from that, LSAs were used to record the current state of musical practices in society (e.g., Lehmann-Wermser & Krupp-Schleußner, 2017). The study of Guhn et al. (2020), however, also provided us with insightful results on associations between music courses and higher achievement in mathematics, science, and English, suggesting positive effects of music education as results remained significant after controlling for SES and earlier achievement. Also scrutinizing this topic, Elpus (2013) analyzed data from the restricted-use dataset of the Educational Longitudinal Study in the US (n = 13,530) to further clarify the relationship between high school music study and standardized achievement measures, finding no significant correlation after controlling for an array of variables such as demography, school effects, and prior academic achievement. Moreover, the ongoing flagship project LongGold

(Müllensiefen et al., n.d.) generates large amounts of data that enable for example network modeling analysis. Network modeling can map complex relationships and interactions, in this case reporting new evidence for associations between engagement with music and personality (Ruth et al., 2023).

In the field of the pedagogy of music-making LSAs can provide us with new insights into populations' musical competencies and music-making abilities. Especially since music-making is culturally determined and shaped by the masses there is the need to address musical phenomena on a large scale (Jorgensen, 2009). Not only in the school context are LSAs indispensable to enable international comparisons and at the same time reveal possible important associations with other variables of interest such as human cognitions or personality traits. As a result of the constant further development of research, including methodological development, reanalyses also appear to be promising here (e.g., Feldhaus & Kreutz, 2021). Notwithstanding, it should be kept in mind that this approach generates broad descriptive knowledge about the target population, but due to the cross-sectional design, no causal conclusions can be drawn from the results (Müllensiefen & Harrison, 2020; Nagengast & Rose, 2018).

4.3 Longitudinal studies

Longitudinal studies are not quite as rare as large-scale studies in research on music-making issues, and in the last decade, a lot has happened in this area – especially from a methodological point of view. Until a few years ago, chosen designs were often qualitative, e.g. representing case studies, and sample sizes were very small. This can be seen in the overview provided by Michael Forrester and Emma Borthwick-Hunter (2015) which illustrates the great research interest in the development of musical skills and musicality in early childhood and simultaneously comes to the conclusion that no uniform picture of musical cognitive development has yet been achieved, which could be due to the individually selected small samples to be analyzed and the very different analysis methods used. One exception is the field of giftedness, which was the subject of several longitudinal studies with large samples in the 20th century (e.g., Heller, 2013; Terman, 1926).

The focus on small-sampled qualitative data is understandable, given that longitudinal studies with large samples are very resource-intensive and require a very passionate long-term commitment from lead researchers to one project which produces few publications, at least in the initial years. Estelle R. Jorgensen (2009) underlined that "researchers opt for narrow, modest and short-term studies that result in more-or-less immediate rewards. Changing this reality requires valuing research differently and altering the mind-set of researchers in music education and in the academy to reward fewer long-term and substantial studies that come to fruition less frequently" (p. 413). The required rethink seems to have taken place somewhat in recent years. Dealing with the effects of music education on child development, Ilari (2020) analyzed 39 studies and reported a "predominance of quantitative data, with little to no mentioning of qualitative data or mixed-methods approaches" (p. 13). Her overview also shows that most longitudinal data collections focused on specific after-school or in-school programs like "Jedem Kind ein Instrument (JeKi)" (e.g., Krupp-Schleußner, 2016; Schwippert et al., 2018) or El

Sistema-inspired music programs which might show the difficulty of reaching regular institutional music lessons or music-making in various amateur leisure constellations. Other longitudinal research from the last few years focused on music-making in the home environment (e.g., Williams et al., 2015), the development of musicality (e.g., Labonde & Müllensiefen, 2022; Müllensiefen et al., 2022), associations with personality (e.g., Krupp & Hasselhorn, 2023) and academic achievement (e.g., Yang et al., 2014), health issues (e.g., Cruder et al., 2023) as well as pursuing a career as a professional musician (e.g., Dobrow & Heller, 2015; Hill et al., 2019). So, important steps in the right direction have been taken and studies are becoming available that provide us with meaningful insights into musical instruction and music-making-related issues, but they have generally yet to be situated and discussed in the general educational context.

Against this background, we should pursue following large samples over several years to get reliable results that are widely disseminated and that can provide a basis for discussion in general education debates. The combination of large-scale and longitudinal designs, such as the LongGold project (Müllensiefen et al., n.d.), would be ideal for tackling questions that are paramount for policymakers and that enhance our understanding of the development of music-making competencies and interdependencies with music-unrelated variables. For example, Hsin-Rui Lin et al. (2022) combined both research designs to investigate the effect of personality and self-theories on academic achievement in music, and Kenneth Elpus and Carlos R. Abril (2024) examined data from the High School Longitudinal Study of 2009 to discern patterns of participation in elective music ensembles in the US. Moreover, it is imperative to address questions on music-making from a long-term perspective as music-making and engaging with music accompany people for a lifetime and shape their everyday life and personal constitution in the long run. Longitudinal studies are therefore necessary to prove measured short-term effects, and, at best, follow-up tests should be sought.

4.4 Intervention studies

To gain changes in our educational landscape, intervention studies are of high relevance. They are used to find new ways of teaching, test newly developed curricula, or investigate the transfer and application of new learning content. Referred to as the "gold standard" by Alvan R. Feinstein and Ralph I. Horwitz (1982), randomized control trials (RCTs) are a particularly desirable goal in educational research. By comparing outcomes from randomly assembled experimental and control groups, RCTs are carried out to make statements about causal effects and therefore enable researchers to give well-founded suggestions for improvements. This leads us to conclude that we should also strive for RCTs in research on the pedagogy of music-making to get to the bottom of the assumed positive effects inherent in music. But this brings us to a point where precisely these presumed inherent effects of music-making stand in our way.

Since music-making is expected to unfold its potential in the long term, we would not only need short-term RCTs but also RCTs over several years to test effects on personality development or intellectual abilities, for example. However, everyone should be allowed to choose a musical education, and in particular, children, who would be of main interest as a sampling group, should not be prevented from accessing musical experiences in the interest of

statistical control (if this is even possible). Based on the premise that everyone should receive a musical education, it seems unethical to randomly assign subjects to control groups without access to musical education for extended periods. In most cases, therefore, we cannot proceed experimentally but must adopt quasi-experimental approaches and examine existing groups or programs. Moreover, crossover designs with different musical interventions could be an alternative here, in which several treatment groups receive each intervention, albeit with a time delay (e.g., Bittman et al., 2003; Street et al., 2015). Apart from the questionability of taking the decision for musical education away from study participants when conducting long-term RCTs, randomization is always a challenge as we are often limited due to institutional structures or bureaucratic circumstances, which results in research designs that are neither comparable nor replicable. For example, block randomization is often a trade-off (e.g., Herrera et al., 2011; Jaschke et al., 2018). This is reinforced by the difficulty of conceiving comparable interventions when it comes to music-making issues, involving questions about what musical treatments should look like, how intense and how time-consuming they should be, and which group comparisons make sense (Ilari, 2020; Müllensiefen & Harrison, 2020).

Quasi-experimental designs with no randomization limit the validity of the results as individuals who choose to pursue a musical education or groups who enjoy a specific training or program may differ from those who do not (Müllensiefen & Harrison, 2020). This became obvious in the review by Giovanni Sala and Fernand Gobet (2020). By comparing intervention studies with and without randomization they could show that studies with random allocation of subjects tend to have smaller effect sizes, suggesting that positive findings of previous studies may be due to confounding factors. In this light, on one hand, it is positive that the number of studies applying quasi-experimental designs has increased over the last years, in particular concerning questions around music-making and its effects on brain activities, cognitive functions as well as academic achievement (e.g., Habibi et al., 2018; Ilari, 2020; Roden et al., 2014; Sala & Gobet, 2020). On the other hand, however, results from these studies must be scrutinized very critically and the existing RCTs with weaker effects must probably be considered more significant. Even if the results are sobering at first, we should continue this path and use the existing studies as starting points for clarifying further questions. Meaningful RCTs are also available about the effects of music-making on cognitive and academic development in particular (e.g., Cogo-Moreira et al., 2013; Costa-Giomi, 2004; Degé & Schwarzer, 2011; Kaviani et al., 2014; Sala & Gobet, 2020), but likewise in the field of geragogics (e.g., Narme et al., 2014; Särkämö et al., 2014). Additionally, music education researchers are encouraged to consider recent advances in quasi-experimental designs such as regression discontinuity (RD) and propensity score analysis that allow stronger arguments for causal relationships (Miksa & Elpus, 2018).

5. Conclusion

Systematic research on music teaching and learning now has at least a century of published work to inspire reflection, and periodic considerations of the "state of music education research" appear in the proceedings of major journals and conferences (e.g., Price, 2018; Reimer, 2008).

We have noted some challenges that seem to be perennial, and the general trend of inquiry and publication seems to follow the methodological and socio-political landscape of particular times and regions. Underlying this aggregated work are individual researchers, with a shared (but often unstated) belief that learning in music is distinct from learning in other domains, that it is important intrinsically as a component of a complete education, and that its benefits extend to other aspects of human life and society. Research is designed to describe constructs, events, and interactions, demonstrate relationships between variables, and guide the implementation of educational practices and systems to foster the positive intended results.

Broadly speaking, the development and application of specifically quantitative research methods have advanced our basic and applied capacities in nearly every field of human endeavor. One only needs to consider the 21st-century "normal" with regard to medicine, communications, manufacture of goods, transport, or agriculture, to see how the conception of "science" as a powerful tool, capable of solving our problems, can be situated in the mind of the public (and policymakers). Researchers in music education operating within this paradigm face the challenge of acquiring a deep working knowledge of music (as a phenomenon), teaching (as practice), and all aspects of quantitative research (design, analysis, interpretation). Typically, this induction and development occurs in university graduate programs and careers are sustained against the backdrop of university tenure and promotion incentives. This is important, as the combination of competence, motivation, and opportunity conspires to keep the population of quantitative researchers in the field rather small. Networking does occur through conferences and the activities of various societies and institutes, but for the most part, researchers are primarily free agents in pursuing their inquiries.

The underlying assumptions of empirical (observation-based) inquiry have been questioned for decades – for example, Karl Popper's critiques of logical positivism in philosophical circles continue to resonate as we attempt to define variables, measure them, and reflect "reality" within the complex matrix of the individual and society (Popper, 1992). A current re-evaluation of the tools and techniques of quantitative educational research, influenced by critical theory, asks that we reflect on the legacy of psychometrics, intelligence testing, and other applications of quantitative methods in current research practice and the development of the next generation of researchers (Frisby, 2024). We believe that constant attention to fundamental elements (definition of variables, elimination of bias, practical versus statistical significance of results, unintended consequences in interpretation) can only strengthen the contribution of quantitative inquiry, and robust dialogue should continue to be a hallmark definition of a scholarly community. In the last 20 years, scholarly journals have continued to expand the methodological arena to include more qualitative, narrative, and phenomenological research reports. Quantitative methodology is one important tool in the toolbox, yet its utility depends on keen discernment of when and how it can be of best use. Jack J. Heller and Edward J. P. O'Connor (2006) remind us that "[o]nce the researcher has identified a problem, appropriate means for addressing that problem should be decided. For most research questions, there are multiple techniques that can provide answers to the researcher's hypotheses. The issue should be which approach is appropriate for the question(s) asked" (p. 39). When the decisions to be taken regarding a school's curriculum can affect thousands of individuals and require the

commitment of millions of dollars (or euros), we believe the public and policymakers both deserve the benefit that rigorously designed quantitative research is uniquely positioned to provide.

With this in mind, we return to Scripp's summary of future directions from the 2002 publication *Critical Links*: to continue to define and explore the development of specific musical understanding and skill, continue to develop measures to demonstrate cross-disciplinary learning effects, continue to examine optimal conditions for achieving those effects, and to continue to situate music learning in the broader context of socio-emotional development and therapy. These remain important goals, and researchers today have new opportunities created by advances in data science, machine learning, exploratory data analysis, and data visualization.

Pursuing this agenda is a challenge, and progress in the field has been perhaps slower than some of us scientists reseraching in this field would like. Individual researchers engaged in short-term projects are indeed capable of producing interesting results, and the incentive structures of universities seem to channel energy in this direction. What is needed, in our view, is a focus on a few key questions (or groups of related questions), with a reasonable consensus about theoretical constructs, operationalized variables, and measures. Where might this focus come from? Certainly, research agendas can be developed and funded through private foundations, research institutes, or governmental organizations – but ultimately, it will be the community of scholars, equipped with the knowledge and skills to define the agenda, that can initiate strategic projects at scale. Music teaching and learning occur in a myriad of global settings and within contexts of families and general socialization, one-on-one instruction, classrooms, and ensembles. This is a daunting landscape to map, and even some general pathways can help channel research energies in ways that offer the prospect of creating a coherent result. We believe that with careful and ongoing attention to aims, designs, and dissemination, quantitative research on the pedagogy of music-making continues to offer the potential for unique and meaningful insights.

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Patrizia Bieber
University of Tübingen | State University of Music and the Performing Arts Stuttgart
Hector Research Institute of Education Sciences and Psychology | Institute for String and Plucked String Instruments
Europastraße 6 | Urbanstraße 25
72072 Tübingen | 70182 Stuttgart
Germany
E-Mail: patrizia.bieber@uni-tuebingen.de | patrizia.bieber.la@hmdk-stuttgart.de
Research interests: Musical education in primary school, family influences on learning an instrument, development of musical and technical skills, transfer effects of musical education, improving musical competencies using digital tools

Bret Smith
Central Washington University
400 E. University Way
Ellensburg, WA 98926
USA
E-Mail: bpsmith@cwu.edu
Research interests: Motivation in music learning, instrumental music pedagogy, measurement and evaluation in music education, arts education policy

Richard Göllner
University of Potsdam
Department of Educational Sciences
Karl-Liebknecht-Str. 24-25
14469 Potsdam
Germany
E-Mail: richard.goellner@uni-tuebingen.de
Research interests: Teaching quality, learning processes during classroom lessons, teachers' instructional language, students' personality and trait change, virtual reality in research on teaching and learning

Keywords for keywording: *Research on the pedagogy of music-making, quantitative empirical research, research methods and designs, music in empirical educational research, music-making in the context of education*

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