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# Three Facets for the Evaluation of Musical Instruments from the Perspective of the Musician

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**Abstract**

Evaluation of musical instruments is a challenging topic and currently lacks common ground and accepted methods. We aimed to address this issue by developing a questionnaire for the evaluation of musical instrument quality from the perspective of the musician. We discovered three interrelated facets of how musicians experience musical instruments. We found that musicians focus on (1) experienced freedom and possibilities, (2) perceived control and comfort and (3) perceived stability, sound quality and aesthetics when they evaluate musical instruments. This structure is similar to research regarding the conceptualization of violin quality. Thus, it is suggested that musicians who use different instruments tend to have an analogical concept of instrument quality. The questionnaire therefore should allow for assessing the subjective quality for various musical instruments.

**Author Keywords**

Music and HCI; Musician Experience; Evaluation; Exploratory Factor Analysis; Psychometric Measurement

**ACM Classification Keywords**

H.5.2 [User Interfaces]: Evaluation/methodology; J.4 [Social and Behavioral Sciences]: Psychology; J.5 [Arts and Humanities]: Performing arts



**Figure 1:** The applied procedure with its three consecutive studies.

## Introduction

In the domain of traditional musical instrument evaluation, researchers investigate sensory perception, preference judgements and their correlation to objective physical parameters [5]. The overall goal is to find predictors of instrument quality and to detect factors that influence subjective quality judgments. For example, for the violin it was found that monetary value and historical importance might cause a biased quality impression [4] because violinists preferred newer violins over old Italians (e.g. Stradivari) when they were blind-folded. Fritz and Dubois [5] therefore suggested to study how complex preference judgments are formed. This leads to the question on what quality attributes musicians subjectively perceive musical instruments.

Evaluation in the field of New Interfaces for Musical Expression (NIME) is driven towards an according approach by recently more and more embracing a musician-centered perspective [1]. However, there appears to be no common definition of evaluation or a consensus about relevant evaluation criteria in the field [1]. This might be the result of a special property of frequently assessed digital musical instruments. Their gestural interface is separable from the sound producing unit [10], leading to the possibility of considering different levels of granularity for evaluation and producing diverse evaluative goals [1]. Consequently, researchers tend to use ad-hoc questionnaires which do not fulfill psychometric requirements in terms of reliability and validity and therefore restrain comparability [9]. In [13] it was suggested to adapt HCI-questionnaires for the evaluation of digital musical instruments (e.g. System Usability Scale, [3]). Although this might be beneficial, we believe that such an approach omits to address the distinct requirements that come along when musicians interact with musical instruments.

Hence, we suggest that a suitable measurement tool for a holistic evaluation of both traditional and new musical instruments needs to be carefully developed. To achieve this, we conducted an exploratory bottom-up development process of a psychometric questionnaire in three subsequent studies (Figure 1).

## Method: Questionnaire development

The applied procedure was inspired by development procedures of psychometric measurements in Psychology and HCI [9]. In study one, we conducted interviews with eleven musicians from various backgrounds using different musical instruments (including both acoustic and digital instruments), extracted 330 single statements and used those to create an initial item pool. Musicians were extensively asked to report features of good and bad musical instruments and about their reasoning behind those attributes. Next, we semantically reduced the statements and grouped them in an affinity diagramming workshop. This method can be used for grouping information in order to develop categories that summarize the content of the statements. The initial item pool was based on those categories and counted 100 items. In the second study we further reduced the item pool by asking 47 music research experts how important they perceived each item. Because experts showed a rather low interrater-agreement, we were only able to marginally reduce the item pool and thus reached a set of 80 items. In study three,  $N = 300$  musicians answered those items regarding a memorable experience when testing a new musical instrument. This could have been any musical instrument in the view of the participants which led to many different instruments. Based on that data, an exploratory factor analysis (EFA) was conducted. By following recently recommended guidelines for EFA in HCI [6] we found three factors. Based on those recommendations we further reduced the item pool by 37 items.

## (1) EFP

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- The instrument allows me to learn new things
- The instrument offers me new possibilities of things to do
- I can continually discover new things by using the instrument
- The instrument offers me new facets of playing

**Table 1:** Four example items of the EFP-facet.

## (2) PCC

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- I feel in control of the instrument
- I can play precisely on the instrument
- I can use the instrument intuitively
- I feel comfortable when I play the instrument

**Table 2:** Four example items of the PCC-facet.

## Results and discussion

The resulting questionnaire consists of three interrelated facets (factor intercorrelations ranging from Pearson's  $r = .60$  to  $.66$ ) that are represented by 43 items in total. The subscales show high internal consistencies indicating a reliable psychometric measurement tool (see Table 1). Interestingly, the factor structure is remarkably similar to a lexical analysis of interview data in [11] which resulted in a dimension space for the conceptualization of violin quality (*Relevance*, *Handling* and *Sound*). In Table 2 each facet is represented by four example items.

### (1) *Experienced freedom and possibilities (EFP)*

EFP is represented by 17 items and relates to the desire of exploring new and unknown possibilities through a musical instrument and therefore is of hedonic nature. Additionally, expressivity may serve as an underlying motive of this facet. EFP shows similarities to Saitis' *Relevance* which consists of two aspects: a) affective reactions which relate to hedonic aspects such as interestingness, enjoyment, fascination or beauty, and b) musical and emotive potential, including characteristics of expressivity that the instruments allows the musician to convey [11].

### (2) *Perceived control and comfort (PCC)*

PCC consists of 15 items related to control and comfort by including ergonomic aspects of musical instruments. With reference to Saitis' *Handling* dimension, PCC is related to the overall playability of a musical instrument. It thus relates to usability in terms of allowing the musician to articulate well or being able to easily play. Ergonomic aspects include the fit of size, shape or weight [11]. Taken together, musicians tend to highly associate control and ergonomics. The role that the haptic modality occupies in musical interaction [7] is of particular relevance for this facet. Musicians use tactile cues for enhanced control and performance [2].

Therefore, PCC may play an important role in haptic research and should be object of further investigations regarding its sensitivity for changes in haptic feedback.

### (3) *Perceived stability, sound quality and aesthetics (PSSQA)*

The heterogeneous PSSQA-facet shares common content regarding sound quality with Saitis' dimension of *Sound* and counts 11 items. Saitis' dimension does however exclusively account for different characteristics of sound quality. PSSQA includes high interrelations of sound quality, instrument stability and aesthetics which may point towards an interesting phenomenon in HCI: the interplay of beauty and usability [12] which may also explain biased impressions of violins as in the study of Fritz et al. [4].

## Limitations, conclusions and future research

In our development procedure we may have missed further relevant quality criteria and the questionnaire still needs further refinement since some items still overlap on a textual level. Thus, we plan to further refine and validate the questionnaire in subsequent studies. With regard to the lack of available psychometric measurements in the field of NIME we provide an initial tool for the assessment of subjectively perceived qualities of (new) musical instruments. Based on the collection of a broad range of quality attributes, we carefully reduced our initial item pool to identify the key quality criteria. Our results can serve as guidance in design and evaluation in the field similar to established measurements in HCI (e.g. [9]). The objective of the questionnaire is not to evaluate how "good" a musical instrument is, but rather to illustrate how it is perceived by musicians in regard to the different quality dimensions, and whether the musicians' perception corresponds with the expectations of the instrument designer. However, the stability of the factor structure needs to be subject of further validation for different types of musical instruments by means of confirmatory factor analysis.

### (3) PSSQA

- I think the instrument is very well manufactured
- The instrument produces high quality sound
- I think the instrument is reliable
- The instrument looks appealing

**Table 3:** Four example items of the PSSQA-facet.

Subscale	Items	C. $\alpha$
EFP	17	.97
PCC	15	.96
PSSQA	11	.94

**Table 4:** Number of items per subscale and their internal consistency (Cronbach's  $\alpha$ ).

For example in [8] it was found that musicians related different positive and negative aspects to either digital or acoustic musical instruments. In study 3 we let musicians decide by themselves what a musical instrument is which probably led towards a more traditional conceptualization in terms of acoustic or existing instruments. Therefore, we believe similar to [13] that within the scope of NIME, the questionnaire is more suitable for instruments that share more similarity to existing musical instruments. Finally, we want to emphasize this is only a first step towards the demanding objective of measuring musical instrument quality from the musician's perspective.

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