University of Helsinki, Department of Teacher Education, Research Report 392

Pirkko Juntunen

Enjoy Playing! Introducing a new technology-based together playing approach to complement traditional teaching in music schools

A study of an audio supported practice aid for first and second grade string instrument students

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Reviewed by
Professor Kimmo Lehtonen, University of Turku
Associate Professor Kristi Kiilu, Estonian Academy of Music and Theatre

Custos
Professor Heikki Ruismäki, University of Helsinki

Supervised by
Docent Inkeri Ruokonen, University of Helsinki
Professor Heikki Ruismäki, University of Helsinki

Official Opponent
Professor Jukka Louhivuori, University of Jyväskylä

Cover
Pirkko Juntunen
Eine Rossi

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Abstract
This thesis introduces and explores a new aural based approach for play-together education of first- and second-grade string instrument students in music school. The research problems are to create a music technology –based teaching method and to study violin and play-together learning in the context of music technological applications. The theoretical background is based on new learning environments, *blended learning* and *flipped classroom* in music education.

In this recent method, *Playback Orchestra,* the students practice their part with the support of an audio of the full score, in most cases the playback of a

notation program. Hearing the audio supports learning the harmony, rhythm, and dynamic changes. The learning situation is a kind of a virtual play-together rehearsal: it is essential that playing continues without stopping at mistakes, which are corrected afterwards. The method is a *learning by doing* approach and the flow-like practicing strategy develops flexibility, which is essential in play-together situations.

The *Playback Orchestra* method was tested with first (N=10) and second (N=4) grade string instrument students of a music school with a quasi-experimental study design. The test group (*playback group*) practiced a score with the support of an audio and the control group (*no playback group*) without it. The aim was to find out if there were differences between study groups in learning.

The first research question was: which playing skills possibly benefit from the audio background, the performance as a whole, understanding the atmosphere, style and general structure of the music, right and left hand technique, reading the score, or play-together skills. The second research question was concerned with learning improvisation: does the audio background support starting the improvisation decisively, continuing it intensively and logically, finding and maintaining the flow and atmosphere, finding own ideas and showing independence and joy of playing, using relaxed movements and creating a general structure in the improvisation.

Two professional violin teachers evaluated the play performances from video before and after a practice period and the quantitative analysis was made with SPSS 22 using general linear model and linear mixed model, which can be applied for small study groups.

The results showed that when the piece of music to be learned was a main melody of a chamber music composition, the *playback group* had learned faster than the other group essential features connected with understanding the musical content: the style and atmosphere and the general structure of the music. The *playback group* had learned musical communication and leading a group by playing better than the *no playback group*. This finding was significant in large numbers.

Concerning the instrument specific technique, audio background seemed not to have clear beneficial effects. However, the students learned to use singing bow style when practicing with the support of a CD track from film music better than without it, the difference was significant in large numbers. When the score to be learned was in baroque style, expressing “terrace dynamics”, an essential feature of the genre, benefited from the audio background in significant numbers.

The improvisation study was a by-product when testing the learning of a musical tale with many sections in different keys, playing styles and atmospheres. The improvisation task was to describe storm by playing. The results showed

that musical story telling in improvisation passage benefited from practicing the musical tale with the playback support.

Because the study groups were small, the results cannot be widely generalised. However, the aural based approach seems to create a good basis for learning deep understanding of musical content. Further, because learning is fast, using the *Playback Orchestra* method makes possible for instrument teachers to create well-working play-together culture with large repertoires.

The pedagogy of music institutions at its best includes both traditional and new learning environments, such as *blended learning.* New technological applications can benefit playing and play-together skills and lead to richer musical expression and joy of playing. More research and open-mindedness is needed in order to the new ways of thinking, using and developing new tools could be included in the curricula of music institutions. In this way using the traditional methods together with new approaches the appreciated Finnish music education system can develop and offer even better quality of education.

Keywords: string instrument education, orchestra teaching in music schools, technology-based music education, new music learning environments, blended learning

Tiivistelmä

Tämän artikkelipohjaisen väitöstutkimuksen tavoitteena oli selvittää kuulopohjaisen oppimismenetelmän toimivuutta musiikkikoulun ensimmäisen ja toisen perustason jousisoitinopiskelijoiden yhteismusisoinnin opetuksessa. Tutkimustehtävänä on luoda uutta instrumenttipedagogista tietoa ja kehittää musiikkiteknologiaa hyödyntävä menetelmä viulunsoiton ja yhteismusisoinnin opetukseen.

Tutkimuksen teoreettisen taustan muodostavat uusien oppimisympäristöjen, kuten *sulautuvan oppimisen* (blended learning) ja *käänteisen luokkahuoneen* (flipped classroom) kaltaisten mallien tarkastelu musiikkikasvatukselliseen kontekstiin liitettynä.

Tarkasteltavassa oppimismenetelmässä oppilas harjoittelee omaa soittoosuuttaan soivan taustan tuella. Taustana käytetään useimmissa tapauksissa nuotinnusohjelman playbackiä. Taustan avulla opitaan kuulemalla musiikin harmonia, rytmikuviot, dynaamiset vaihtelut ja artikulaatiotavat. Menetelmää kutsutaan nimellä *Playback Orchestra*. Kysymyksessä on eräänlainen virtuaalinen yhteissoittoharjoitus, jota voidaan käyttää sekä kotona että omalla soittotunnilla harjoittelun tukena. Menetelmässä on olennaista soiton keskeytymätön jatkuminen orkesteriharjoitusten tapaan. Virheisiin ei takerruta tai pysähdytä vaan ne korjataan jälkeenpäin, mikä tukee yhteissoitossa tarvittavan joustavuuden kehittymistä. Koska soittamaan opitaan soittamalla, kysymyksessä on uutta teknologiaa hyödyntävä kokemuksellinen (*learning by doing*) tapa oppia

Playback Orchestra menetelmää testattiin tässä tutkimuksessa musiikkikoulun ensimmäisen (N=10) ja toisen perustason (N=4) jousioppilailla kvasieksperimentaalisella koeasetelmalla, jossa testityhmä (*playback ryhmä*) oli harjoitellut yhteissoittokappaletta soivan taustan tuella ja kontrolliryhmä (*no playback ryhmä*) ilman taustaa. Tutkimuksessa haluttiin selvittää, voidaanko koe- ja kontrolliryhmän välillä havaita eroja soittajien edistymisessä.

Ensimmäinen tutkimuskysymys oli, mitkä soiton osa-alueet mahdollisesti hyötyvät soivan taustan antamasta tuesta: soittosuorituksen kokonaisuus, tyylin, tunnelman ja musiikin rakenteen hahmottaminen, vasemman ja oikean käden tekniikka, tai nuotinluvun ja yhteissoittotaitojen kehittyminen. Toiseksi tutkittiin, kehittyvätkö soittajien improvisaatiotaidot paremmin soivan taustan avulla kuin ilman sitä: onko testiryhmien välillä eroja improvisaation aloittamisessa, intensiivisessä ja johdonmukaisessa jatkumisessa, kehittyykö tunnelman tavoittaminen, soittajan keskittyneisyys ja itsenäisyys, omien ideoiden keksiminen, soittamisen ilo ja rentous soitossa. Tarkasteltiin myös, tapahtuiko improvisaatiojakson kokonaismuodon luominen paremmin soivan taustan tuella, vai ilman playback-taustaa harjoitelleilla soittajilla.

Kaksi musiikkiopiston viulunsoitonopettajaa arvioi numeerisesti soittoesitykset videolta ennen ja jälkeen harjoittelujakson. Testitulokset analysoitiin kvantitatiivisesti SPSS 22 ohjelmalla käyttäen *general linear model*- testiä sekä pienil-

le aineistoille soveltuvaa *linear mixed model*- testiä tulosten tulkitsemisen pohjaksi.

Tutkimustulokset osoittivat, että harjoiteltaessa nuottia, joka oli yhteissoittokappaleen päämelodia, playback-taustan avulla harjoitellut ryhmä oppi toista ryhmää paremmin keskeisiä musiikin ymmärtämiseen liittyviä piirteitä, kuten tyylin ja tunnelman tavoittaminen ja kappaleen rakenteen hahmottaminen, sekä kehittyi musiikillisessa kommunikoinnissa tilastollisesti erittäin merkitsevästi paremmin kuin kontrolliryhmä.

Ryhmien välillä ei havaittu merkitseviä eroja soittotekniikan kehittymisessä, poikkeuksena jousikäden soivan äänenmuodostuksen merkittävä parantuminen elokuvamusiikki-taustan kanssa harjoitelleilla toisen perustason viuluoppilailla. Barokkityylisessä orkesterikappaleessa, soivan taustan avulla opiskelleet oppilaat toteuttivat merkitsevästi paremmin tyylille ominaisen terassidynamiikan kuin verrokkiryhmän oppilaat.

Improvisaatiotutkimuksessa testattiin soivan taustan toimivuutta lyhyessä musiikkisadun jaksossa, jossa tehtävänä oli kuvailla myrskyä soittamalla. Musiikkisatu koostui useista, tunnelmaltaan, sävellajeiltaan ja soittotavoiltaan erilaisista jaksoista. Tulosten perusteella voidaan todeta, että improvisaatioesityksen johdonmukainen jatkuminen, tarinan kerronta, toteutui paremmin playback-taustan avulla harjoitelleella ryhmällä.

Vaikka tutkimuksen tulosten yleistettävyyttä rajoittaa tässä tutkimuksessa otannan pienuus, näyttää esitelty kuulopohjainen lähestymistapa luovan edellytykset syvällisemmälle musiikin ymmärtämiselle kuin traditionaaliseen paperinuotista opiskeluun rajoittuva oppimistapa. Tutkimuksessa kehitelty playback-menetelmä nopeuttaa oppimista ja antaa sen vuoksi soitonopettajille mahdollisuudet luoda riittävän laajoja ohjelmistoja toimivan yhteismusisoinnin kulttuurin rakentamiseksi.

Musiikkioppilaitosten instrumenttipedagogiikka on parhaimmillaan kokonaisuus, jossa uudet oppimisympäristöt, teknologiset sovellukset ja sulautuvan oppimisen lähestymistavat voivat edistää oppilaan soiton ja yhteismusisoinnin taitoja sekä musiikillista ilmaisukykyä. Uuden oppimispedagogisen ajattelun ja teknologian sovittaminen musiikkioppilaitosten opetussuunnitelmiin vaatii jatkotutkimuksia ja ennakkoluulotonta lähestymistapaa liikkua erilaisia oppimisympäristöjä hyödyntäen ja niitä edelleen kehittäen. Traditioon nojaten ja uuteen ennakkoluulottomasti asennoituen voi arvostettu musiikkioppilaitosjärjestelmämme näin kehittää yhä laadukkaampaa opetusta.

Avainsanat: jousisoitinopetus, musiikkikoulun orkesteriopetus, musiikkiteknologia-avusteinen musiikinopetus, uudet musiikin oppimisympäristöt, sulautuva oppiminen

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Contents

List of figures

List of tables

List of appendices

List of original publications

In the following study, these publications will be referred to by using the Roman numerals.

I. Juntunen, P., Ruismäki, H., & Ruokonen, I. (2011). Music technology in Finnish string instrument and orchestra instruction. In Ruismäki, H. & Ruokonen, I. (Eds.), *Design Learning and Well-being: 4th International Journal of Intercultural Arts Education: Post-Conference Book: University of Helsinki, Department of Teacher Education. Research report* 331, 97–114.

II. Juntunen, P. (2011). Music technology promoting violin and string instrument instruction. *CFMAE Interdisciplinary Journal of Music and Art Pedagogy.* Vol.3. 17-34.

III. Juntunen, P., Ruokonen, I., Ruismäki, H. (2013). Study of the Potential of Playback Orchestra Computer Assisted Teaching Method. *The European Journal of Social & Behavioral Sciences,* 10/2013; 1097-1104.

IV. Juntunen, P. (2013). Research on the Effectiveness of Playback Orchestra Music Technology-Based Learning Method. *Problems in Music Pedagogy*, *12*(1).

V. Juntunen, P., Ruokonen, I., Ruismäki, H. (2014). The Impact of Playback in Learning Musicianship Skills and Musical Communication. *CFMAE: Interdisciplinary Journal for Music and Art Pedagogy,* 6 (1).

VI. Juntunen, P., Ruokonen, I., Ruismäki, H. (2015). The Music behind the Scores: A Case Study of Learning Improvisation with the *Playback Orchestra* Method. *Journal of Computer Assisted Learning,* 31: 582-591. doi: 10.1111/jcal.12098.

VII. Ruokonen, I., Juntunen, P., Ruismäki, H. (2013). Experiences of participants in Minifiddlers` distance learning environment. *Problems in music pedagogy 01/2013; 12*(2):93-105.

1 Introduction

Being a music teacher is a wonderful adventure guided by the music itself. Having myself a high esteem and strong emotions connected with music and playing, I have felt the burden of responsibility for my work with talented children who are eager to learn music. How can I teach the students to be creative and sensitive to music, and hard- working with the technical details at the same time? How can I help the children who are just beginning as musicians to gain insight into playing in good style and technique? Because the music seems to be hidden behind the scores, how can I teach the students to find the essential message of music in the course of learning to read scores? In addition, how can a student with less capacity enjoy playing together with others without being frustrated with problems in reading and playing, and difficulty in observing the course of an orchestra rehearsal?

When I started my own violin lessons I was often uneasy and tense when I wondered what my teacher thought about me as a person and my playing. I would ask myself these questions: Is my technique correct, is the sound of my violin good, are the rhythms correct, can I express the music I hear with my inner ear? Nevertheless, I usually left the classroom with a fine view of the music and how to play and practise at home. The best moments from my early studies were when I could play my pieces with an accompanist: I could hear and participate in the whole piece of music, but when practising my orchestra parts I did not know if I played right or wrong my second violin score. My family could not help me at all. However, I remember some special moments from my early stages of learning violin playing as strong and inspiring incidents. One of them was when a substitute teacher said: “You can make your own exercises like those I showed to you for that kind of technical problem”. The ideas of teaching myself with my own exercises and making my own music and arrangements have followed me in all my studies and in my career as a violin and orchestra teacher through tens of years.

Later, as a violin teacher, I had the great pleasure of teaching orchestras, which I thought to be a challenging job. Where can I find scores that motivate me and my orchestra, music in which second violins and violoncellos are more equal partners to the first violin, not only uninteresting and often unidiomatic scores with no melodic contour or musical or technical ideas to wake inspiration in players, how to teach the orchestra students to read the scores fluently and

follow my leading and the playing of others at the same time. In addition to those problems, which kinds of tools could I find to motivate students for home practising and to check whether they practise correctly at home? I wondered how families could support home practising.

To solve these problems I began to create my own material: orchestra etudes and arrangements with pedagogical objectives and technical wiles in all parts of the orchestra score. Later, when I learned to use the computer, I wrote my scores with notation programmes to get more readable and clean scores for my orchestra students; these scores were also tailor made to the taste of orchestra players and their capacities.

Learning to use the computer and its programmes opened a quite new and exciting world for my pedagogy; accordingly, I developed a brand new orchestra teaching method: practising a part score with the support of an audio of the whole orchestra. The audio support that I used was the playback of a notation programme, and I could check simply by listening to hear if there were any mistakes in the orchestra score writing or whether the orchestration sounded good or not. When writing scores with notation programmes, the students could get clean scores, I could edit the scores quickly to be the best possible in various situations, and I could send the scores via email to the students who lived far away from the music school. Nevertheless, the most important finding for me was that the notation programme playback could be used as a learning tool: the students could hear the whole orchestra from the playback when playing their own score and they could decide whether they had played correctly simply by matching their playing with the orchestra playback.

The new orchestra teaching method which I started to use is based on learning with the support of the playback of a notation programme with which the score was written was a kind of "virtual orchestra rehearsal", and the students could use it outside classroom whenever they wanted to. This finding opened many pedagogical doors for me as a music teacher. Because students learned their scores more quickly, I could make my educational repertoire larger, richer and more varied in styles and musical ideas. By adding this new practising element to my orchestra teaching tool palette, I could reach my education outside the classroom. I started to call the new method of practising with the support of an audio of the whole orchestra the *Playback Orchestra* method.

During using the playback of notation programmes as audio support in teaching for fifteen years I found the method effective: the atmosphere when practising and in concerts was relaxed and joyful because the players could trust in their own playing; even the students with lower capacity were motivated and learned well. The repertoires of orchestras grew much larger, which gave the feeling of "good working orchestra life". Finally, I wanted to determine if my experience of the positive outcomes of this learning method, the *Playback Orchestra* method, could be verified by scientific methods. I began to test it. I

wanted to see if this new way of teaching could be a relevant and effective method for orchestra education more generally. Accordingly, I began to figure the features, strengths and weaknesses of my own teaching system, and test the outcomes of using it. At last, I could fulfil one of my dreams from my early years: being a researcher. This dissertation is the result of the testing and considerations on related research literature.

The principal aim of this thesis is to consider a new larger learning environment for string instrument and orchestra education in first and second grade of music school to complement the traditional classroom teaching with technologically based methods which benefit computer software and the Internet. Traditional face-to-face education indicates that teaching is exclusively teacher-centred and based on apprenticeship, i.e., practices under the supervision of an experienced master of the discipline, and on traditional methods of "lecturing" and imitating the performances of the teacher (see Figure 3, the left side). The main questions in this research are: can the new *Playback Orchestra* method support orchestra students in learning to play in harmony of the style and atmosphere of the music, create good phrasing, articulation, interpret dynamic changes, and choose the appropriate quality of sound. Further, by which method they can find a coherent style of using the bow in orchestra and chamber music playing and can the method support learning orchestra scores quickly and correctly and does the method motivate the players to practice the orchestra scores more at home? Considering a larger view on education: is the mixture of traditional face-to-face teaching methods and this new technologically-based method a proper learning environment in string instrument and orchestra teaching and what are the costs and losses of this combination? An overview table of the study, research questions, data collection, data analysis and my corresponding articles on the subject are presented in Table 1.

To build a framework and background to the discussion concerning learning environments in music education it is firstly described how the music education is organized in Finland and which kind of general guidelines are suggested to be followed in music education. Because the students are chosen to music schools through admission tests on musicality, an overview of research and discussions of what musicality is and what are the beneficial results of music activities and the role of music education concerning emotional understanding of music. The guidelines for violin basic education and orchestra and play- together education in music school are also described, as well as some problems and questions concerned with the issue on learning to play violin and on playing together.

In the *basis for the research* section is first discussed the role and the significance of the personality of an experienced teacher, the outcomes of authority in teacher-student interaction and which are the characteristic features and practices of successful teachers and students. Because the educational strategy of instrument teachers has traditionally been based on apprenticeship, the commonly

assumed feature "teaching by demonstration" is discussed, as well as the problems of individual musical interpretation when "copying" the teachers' style of playing, and, on the other hand, which kind of skills benefit from teachers' model. Further, improvising is thought to offer students a creative space within a formally structured teacher-centred lesson, moments during which to explore their own ideas and develop autonomy in the "master-apprentice" pattern of traditional face-to-face teaching. There are reports of students stating that performing their own improvisation or compositions in front of the audience is not so stressful as performing a repertoire piece. The benefits of *learning-by doing* procedures, are also discussed in the *basis for the research* section.

The sharp division between highly specialized musical expertise and amateur music making, as well as the divisions between different musical styles and genres, and the various roles of music makers, has been questioned in the recent situation full of changes. The possibilities of new technological resources, the growing use of the Internet, mobile learning and new social practices in learning have raised discussion on music making and learning inside and outside school. There are new learning environments where the teacher is not the only expert, but the students could benefit from each other in their own growth, in other words, blurring the boundaries between informal and formal music education is also discussed. In the era of *digital habitats* it has been seen important to get new visions of the possibilities for learning at multiple levels. The concept of *cosmopolitan* musicianship(see Partti, 2012), a community in which differing views on musicianship exist at the same time, is discussed also as an indication of drive towards democracy, as well as towards participatory and mutual learning.

In the *basis for the research* section are also introduced the new learning environments which have arisen with the widening use of ICT and the Internet in learning music: *blended learning* and *flipped classroom.* In blended learning the major part of education is supervised by teachers, whereas in the flipped classroom, part of learning takes place beforehand outside classroom as student-centred, self-directed and without supervision (Figure 3). An overview on the extra materials from the Internet for violin education, to be used both at home and during lessons, has been given, as well. A short review has been given on research concerning adults' self-directed music learning with the support of the Internet and the MOOCs. MOOC is an effective format for delivering large amounts of information and numbers of courses, for instance in playing instruments, to be used for free or at low cost for the students. As an example of efforts to create systems that support learning violin technique without supervision of a teacher, are introduced interactive programs based on recording the players' performance and giving feedback afterwards. The important role of a human teacher in directing the whole flow and taking considerate care of the student is discussed.

Distance learning might be the best known string instrument education system using technology. The earliest and latest phases of distance learning, the technical problems when playing together in separate regions via video conference technology, and solutions are described. As an example of recent distance learning, Minifiddlers, a successful and well working combination of young talented violin learners, their families, local teachers and professor Szilvay as the highest educator in the whole environment are also described.

To give background for the recent study concerning auditory support in learning new scores, aural learning strategies are discussed and considered as a complementary or alternative learning strategy to exclusively used learning by sight-reading scores. The final discussions in the *background of the research* section concern learning and other musical activities with mobile devices such as iPad and iPhone. One application in the iPad, a violin-like instrument, the *Magic Fiddle*, and its use is described, as well as the role of mobile phones as meta-instruments in *Mobile Phone Orchestras,* which were aimed *to* explore the possibilities of the fusion of technological artefact and human musicianship. Finally, learning to play with the support of notation programme playback using the *iPad* and its *Avid Scorch* application is described and the *Playback Orchestra* method in learning violin and play-together is introduced. It is a method developed by the author of this thesis and it was tested by pre-post study design described below.

In the *structure of the research* section are described the outlines of the study on the impact of the *Playback Orchestra* method on learning new scores. The study design was quasi-experimental: two professional violin teachers evaluated the playing of the students before and after the practice period, in which the test group (referred as *playback group*) practised with the support of an audio of the whole orchestra and the control group (referred as *no-playback group*) without it. The questions asked of the estimators were based on the guidelines for violin and orchestra education (The Association of Finnish Music Schools, 2005; Conservatory of Kuopio, 2014), and also on the statements of two string instrument teachers concerning the characteristic feature and challenges of the music in the testing (Appendix 8-10). An overview table of the study, research questions, data collection and data analysis methods is described in Table 1.

In the *results* section of this thesis are described the analysis of the data concerning the learning outcomes of three new scores and improvisation with or without audio support. The significances of the differences between study groups were calculated with SPSS 22 and a linear mixed model; nevertheless, the improvisation study used a qualitative approach because of large differences between the tested students and because a more nuanced view wanted to get of this delicate and complex form of music learning. In the *conclusions of the results* section are discussed the results in the light of guidelines for violin and play-together education. Because the results showed that essential features of the

music, such as general structure, style and atmosphere, and crucial elements of playing style were learned faster with the support of an audio than without it, it seemed reasonable to conclude, that the *playback group* learned to *understand* the musical content faster than the other group. It seemed clear, as well, that audio background benefit playing movements in harmony of the style of music and also expressive body language. After analysing the results of the recent study and exploring research literature, concerning musical imagery and memory, a fictive model was constructed to describe learning music in an audio supported environment: a *gearwheel model*. In this model (Figure 18) all parts, which are *hear*, *understand*, *play*, and *memorize,* are connected and interact with each other.

To give more background to the memory part of the metaphorical *gearwheel model*, research and discussions on auditory imagery and tools for studying the imagery, such as BAIS (a short self-report measure encompassing both vividness and control subscales for musical, verbal, and environmental sounds) are discussed, as well as brain imaging technologies used in that field of research and some results were also introduced and discussed in the light of the main results of this research. It has been found that the experience of "hearing" music in one's head is phenomenologically strong; accordingly, it could be considered that auditory imagery once generated might operate like mnemonics by its tendency to involuntarily repeat music in the mind. Thus, smart anticipation of the appropriate future playing and reading actions are grown and help to avoid mistakes in advance. This kind of anticipation could be the basis for faster learning with audio supported practising than without it, which was largely verified in some parts of the data of the testing.

The flow-like learning strategy, which means "letting go" without stopping at every mistake, is a style used in traditional orchestra rehearsals. It is also a characteristic feature of *Playback Orchestra* method, which, in a sense, is a *virtual orchestra* rehearsal situation. This learning strategy leads to flexibility in play-together situations and is therefore an essential skill in music education. The playing and behaviour of the orchestra students seems to resemble features of *Optimal Experience* or *Flow* phenomenon stated by Csikszentmihalyi (1997): it is playing in a relaxed and joyful atmosphere when "letting go" while playing. In addition, to match the challenges of the repertoire to the skills of players, tailor-fitted music, such as arrangements, etudes and compositions, were used to fit the students' skills, which differ largely from each other. Using the audio element, in addition to sight-reading, it was thought that a basis for a more cognitive learning strategy rather than using exclusively the traditional methods could be established.

As the main result of this thesis, a learning environment which includes *both* the best tools, methods and procedures of traditional face-to-face teaching *and* the possibilities provided by the recent music technology to benefit orchestra and

play-together learning is introduced in the next section. The environment creates a good basis for motivated practising outside the classroom and a rich palette of educational tools for teaching and learning in classroom (see Figure 5 and 19). The new education environment, which connects the supervised teacher-centred traditional face-to-face *and* unsupervised student-centred technology-based learning environments, could be called *blended learning* (see the middle part of Figure 3) because it is not restricted exclusively in face-to-face learning (that is to say, the left part of Figure 3).

In the *conclusions* section the results of the research are mirrored to guidelines for education given in the *extensive curriculum in music institutions.* It seems that essential skills mentioned in the guidelines are learned effectively with an aural learning style in the *Playback Orchestra* method (see Finnish National Board of Education, 2004; The Association of Finnish Music Schools, 2005: *The contents of the basic examinations and bases of evaluation in violin education*; the curriculum of the Conservatory of Kuopio, 2014). Using notation programmes and the playback, and other materials and tools afforded by the Internet, seems to be a good educational package for music teachers: the resources are recently easy and quick to access and share with the advanced technology. The new larger learning environment makes it possible to concentrate during the face-to-face situations on more refined details of the orchestra performance, on the coherence of bowing styles, better intonation based on harmony, even on the stage behaviour and appearance of the orchestra or chamber music group. The style of active doing, playing to learn to play, seems to fit especially well for some boys and lively students who like "hands on" activities. Slow and clumsy students have commented that after having the auditory model music and opportunity to repeated trials at own time and pace at home, they feel comfortable playing. Thus, they are prepared to face the obstacles in the social situation in the group lessons. Further, an intimate and close knowledge of the composition to be performed helps the musicians to feel comfortable and safe enough to overcome stage fright.

The *Conclusions* section discusses how part of the results showed differences between study groups (*playback* and *no-playback* group) in highly significant numbers in favour of the *playback group* concerning *understanding the general view and style and atmosphere* of the music. Accordingly, the aural basis of playback learning seems to support playing skills that are stated to be central in learning to play violin: finding a natural style of playing, being able to create the character and atmosphere of the music, to create good sound, intonation, articulation, phrasing and dynamics and perceive simple musical constructions. The aural emphasis and flow-like learning strategy of the *Playback Orchestra* method are also in line with the notion that students in the first stage should learn to play by ear in addition to sight-reading education (see The Association of Finnish Music Schools*: the contents of the examinations and bases*

for evaluation in violin basic education, 2005). The *Playback Orchestra* method seems also to support the students' creativity in interpretation: as the students hear the *contents of the whole piece of music* from backing tracks or other audio recordings, they can create their own interpretation on the basis of hearing the harmonies and other contents, and not to lean only on the teachers' conceptions.

At the end of the *conclusions* section, a wider view on the role of learning environments is drawn: a crucial aim of education should be that the students are afforded the possibility to use and develop all of their capacities and whole personality, and to benefit both brain hemispheres in learning and musical activities. The journey is more important than the ready-made musical product; by learning in "musicians' style" the students grow into great musicians and flexible personalities capable of interpreting many styles of music in various environments. As musicians, they can feel free to create and interpret music in a personal, individual way, safe and relaxed in music making with others; they can develop self-esteem in sharing music with others.

Considering the credibility and authenticity of this recent research, validity, reliability and ethical issues are discussed in detail, and research and views related to these issues. Concerning the formulating of the questions asked of the estimators, it is considered on which basis they have been chosen. Do the researcher and the estimators understand the questions in the same way, and is the scaling style of the measuring tool appropriate concerning the learning outcomes? Is it accurate enough to measure minor changes in play performances? As a conclusion it was stated that all those aspects were planned carefully before testing, and also choosing the quasi-experimental study design with video recorded performances, and analysing the data both quantitatively and, in case of improvisation study, qualitative approach. It was found to be reasonable to admit that in attempting to understand at a finer level how a cause produces an effect in educational research, we must consider that there are mediating and intervening factors involved in testing; accordingly, *Potentially Positive Effects* of the treatment can be seen a reasonable expression of the results in this recent research.

Concerning the reliability, in other words, repeatability of this recent research, it is accomplished by using video recordings; accordingly, the evaluation results can be double-checked by redoing the video based evaluation of the video recorded play performances by additional estimators. It could be predicted that the redoing should give, instead of exactly the same scorings, anyhow, the same *outlines* of results as described in the results section of this thesis. Further, in a strict sense, if the results are aimed at basing future decisions on learning environments, the results should be generalized in the measure that it is scientifically justified. It should be noted that what the superintendent of a school wants to know about new learning environments is not so much what *has* worked, but what *will* work. When and where will a given programme work, for whom will it work, and under what conditions will it work best? However, although educa-

tional policy should be based on empirical evidence, an education programme should in some limited sense have been "proven to work" in a real-life situation. Related to this discussion, there is a long history of using the *Playback Orchestra* method successfully. Although the study groups were too small for wider generalizations, the results give general views on the effect of the method on learning outcomes and show way to further research of the method. As theorists such as Cronbach (1988), Messick (1989), and Shepard (1993) have emphasized, evaluating and creating tests on education environments should be viewed as an ongoing process of scientific research.

In addition to the discussions on validity, reliability and generalisability of the research and the results, in the recent research report has also been taken into account the ethical principles and how the report is made. The families of the tested students gave written permission for video recording and showing the videos of play performances. According to the policy of research principles in the field of sciences, the tested students are addressed anonymously by using player numbers and when writing the research reports, expressions which may lead the participants to a position with dislike or aversion, are avoided. In conclusion, the author acknowledged the possible existence of ethical problems and from the very beginning of planning the study tried to prevent the forthcoming troubles connected with ethical issues and behave with appreciation towards the students and families, as well as the estimators as colleagues, in the same approach as when doing her professional work as a violin teacher.

In the final section of this recent thesis, *discussion and future perspectives*, are discussed the general views on music teachers in front of new views on learning environments, the option of new methods of teaching, new approaches to material, and the position and role of the music teachers between traditional and new, blended learning environments. Advancements in music technology have raised new questions about pedagogy, curriculum and ethics of education. On the other hand, teacher training brings out silent knowledge and produces innovations, and the ideal situation should be that the teachers may teach by the methods they know best, but could have the opportunity to be acquainted with new pedagogical possibilities. The crucial point in planning changes and enhancement to recent pedagogics has been considered to be the experience of professional teachers, but the attitudes of music teachers, and their educators, seem to lie fast on the ground of tradition and instrument specific issues.

The teaching profession is changing and it seems to be clear that any change in educational practices must begin with the teacher education institutions and their students. According to extensive curriculum in music learning (Finnish National Board of Education, 2004), ICT and music technology can be optional instruction in music schools. Accordingly, it also seems that educating teachers in the use of technology is a key component in almost every improvement plan for education and educational reform efforts. The crucial question is: who is

responsible for offering time and tools for discussions and development projects? Is it the headmaster of each institution? Is it the teachers themselves? Is it everyone in the field of music education?

Although the importance of music technology has (more or less) been noticed in music schools, there is next to no ICT pedagogy in teacher education; accordingly, the education policy varies between music institutions from no education at all to institutions that are willing to invest in ICT skills. To make advancements in the situation a recent project has been run on creating guidelines for a model for music technology education as a subject in music schools and piloting it. According to the guidelines, the students should learn with music technology studies to work independently and use and develop musical and artistic skills by means of the programmes, software and devices used in music technology. According to Ruippo (2015), professionals in both technology and education, in other words pedagogic developers, together with application innovators, should be working together when developing technology-based education.

From a personal point of view, the author of this thesis concludes: "Being a violin and play-together teacher in a music school, I think, even if it takes much of my time without bringing any money for me, that experimenting, arranging and composing are the key resources in teaching musicianship skills. Life is changing, and moving at the speed of change is a great *educational* challenge; it is up to us whether we can take this as an opportunity or a tricky situation giving more troubles and needless studying and exploring which leads to nothing but annoys and frustrates us. The speed of change in life goes together well with me".

1.1 Music education in Finland

The modern Finnish music education system, which is widespread throughout the country, is internationally well recognized. Musically talented children have been developed to become successful musicians, members of prominent children's and youth choirs, and famous conductors and singers (Partanen *et al*., 2009). Historically, music was one of the central disciplines in the schools run by the church, because the pupils assisted in church music performances at divine services. The school statute of 1571 mentions only three compulsory disciplines: Latin, religion, and choral music. Mirroring the high status of music in education there was one singing lesson every day.

Currently, following the idea that every human has a right to experience the arts, a right to feel, react to and experience or make art (Kaartinen *et al.,* 2000), there is a broad, publicly financed network of music institutes in Finland: the number of institutes receiving aid is 89. When counting together also the private institutes, altogether there are about 150 music institutes in Finland. Not only children in large cities have had an opportunity to study music; there are professional music teachers all over the country. (Hirvonen *et al.,* 2000.)

The music institutes are intended mainly to educate school-age children (7-18 years), although some students begin even earlier (Hirvonen *et al.,* 2000). There are music kindergartens for pre-school children and Finland also has a widespread music play-school network (Partanen *et al*., 2009). In addition, in many music schools there are also departments for adults (especially singers). The general view of Finnish music education system is described in Figure 1.

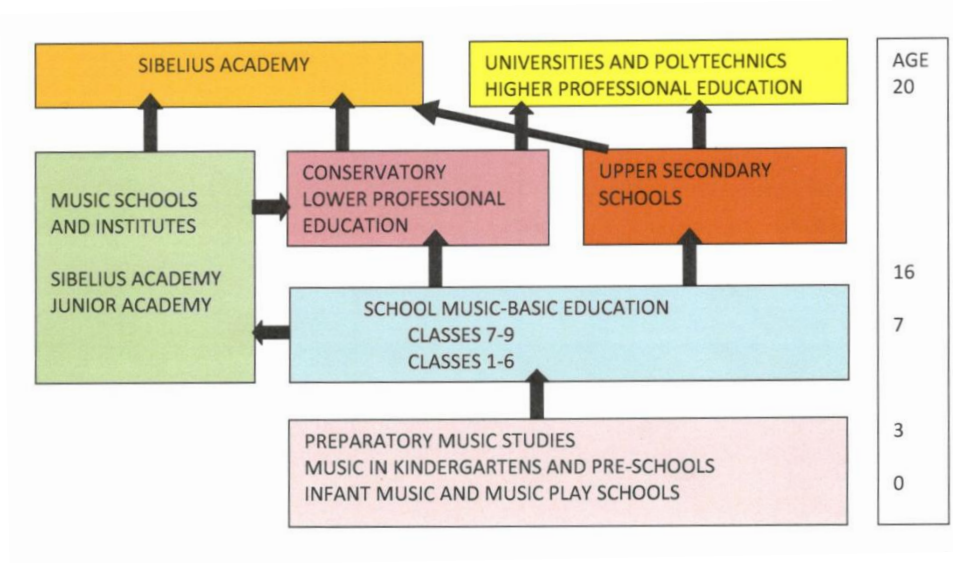

Figure 1. Finnish music education system chart (adapted from Ruismäki & Ruokonen, 2006, applied by Juntunen)

It is also possible to study music in special music classes in Finnish primary schools. Those classes are part of the basic education system with extra music lessons in the curriculum from 3rd-9th grades. In some schools music classes begin in the first grade, but most often students are selected through a musical ability test after two years of study in a primary school (Ruismäki *et al.,* 2006). Altogether there are about 530 music classes in comprehensive schools, with some 14,000 students (Ruismäki *et al.,* 2006). Music classes are important for Finnish schools, because they bring a living music culture into normal school life and help in the celebration of festivals of the calendar year; furthermore, the choirs and orchestras provide a wonderful learning environment for musically

gifted students. According to Ruismäki *et al*. (2006), almost all most prominent Finnish children's and youth choirs are in one or the other way connected with music classes (Ruismäki *et al.,* 2006). After finishing the comprehensive school, students may continue in one of the 12 music-oriented upper-secondary schools with 2,100 students (Ruismäki *et al.,* 2006).

The core of music education is formed by music schools and conservatories which offer systematic instrument teaching and music theory instruction. Education in music institutes is based on the Law of Basic Education in Arts, which defines the guidelines for target oriented music education and for the competence needed to gravitate to professional education. The curricula of the music institutes has been made on the basis of the guidelines given by the National Board of Education and they follow the ideas concerning basic values, learning conception, learning environment and learning methods in music education outlined by the legislation. The music institutes have considerable freedom in their individual curriculum (Sepp, 2014); pedagogical methods, for instance, can be chosen quite freely by faculty in the institutes.

Music schools and conservatories offer goal-oriented studies, with examinations at various levels to measure progress (Klemettinen, 2007). There are two levels in music institutes: the basic level, begun at around the age of seven and usually completed by the age of fifteen, and the music institute level, which the students may attend for about three years. After the basic level, the students may also apply to the professional graduate degree programmes offered by conservatories.

The Sibelius Academy and nine vocational high schools provide higher education in music. The only university-level music institute in Finland is the Sibelius Academy, maintained by the Finnish Government. The degree programmes in the Sibelius Academy are: Performing Arts (with seven instrument groups), Jazz Music, Folk Music, Church Music, Music Education, Music Technology, Vocal Music, Orchestra and Choir Conducting, Composition and Theory of Music, and the two-year Arts Management degree programme. In addition to the Sibelius Academy, the Universities of Oulu and Jyväskylä also offer degree programmes in music education, qualifying students mainly to teach music in comprehensive schools, upper-secondary schools and adult education programmes (Ruismäki *et al.*, 2005). The purpose of these degree programmes is to produce qualified music teachers for northern Finland and sparsely populated regions (Partanen, 2006; Anttila *et al.,* 2005).

1.2 The extensive curriculum in music institutions

The curricula in music institutions are quite individual in detail, but they follow the general guidelines given in the Act on Basic Education in the Arts (633/1998). According to the legislation, the curriculum in basic arts education

can be extensive or general. The extensive curriculum is offered at 98 music schools and 12 conservatories. The music teaching is implemented through a curriculum based on guidelines approved by the Finnish National Board of Education in 2002 (extensive curriculum) and 2005 (general curriculum) (Partanen *et. al*., 2009).

Although learning music is an active and goal oriented process aimed at competence for later vocational music studies, in the extensive curriculum in music the ideas concerning creating a basis for good lifelong relationship to music, advancing growth of personality, and social skills and creativity are highlighted. In music education the learning environment is crucial: it should be open, encouraging and positive, giving experiences of success. Further, the learning environment should allow the students to set their own goals, work independently and with others.

The contents of teaching music at the basic and institute level include learning instrument skills, playing together and learning the basics of music. The main object of the music studies is to learn the basic technique and repertoire of the main instrument, to read and write scores, to become acquainted with and listen to the music repertoires and develop ability for musical expression and performance, and to learn skills for playing music together. According to the extensive curriculum, playing together is begun at as early a stage as possible and it is continued throughout all the studies in the music institution. Reading and writing scores is aimed to be integrated with instrumental and play-together instruction and the studies of the basics of music gives skills for singing and writing melodies in major and minor keys, perceiving rhythm and harmony, composing music and, if possible, using music technology in the studies. In conclusion, the music education aims to develop the musical abilities of the gifted students and provide tools for expressing their musical world in solo performances as well as with others, as self-directed learners and socially refined musicians, who are also creative and responsible individuals.

1.2.1 Musicality, music education and the beneficial results of music activities

Music and music education have largely had high esteem in the different eras of mankind. As early as in ancient Greece music was one of the first studies in children's` education because it was thought to provide a basis for sophistication and support further studies in subjects like mathematics. *Musicae*, which denoted mental education, included in addition to music, also writing and reading and was begun long before sports and gymnastics (Flaceliere, 1959). In modern times the students for music institutes have been chosen mainly through musicality tests and by considering other capacities of the future students on learning music.

Hallam (2006, 122) defined the word "musicality" as "being musical", which means having musical talent and potential. In general, the admission tests for music school are aimed to measure the features which are connected with musical and other abilities that are needed in formal music learning. Nevertheless, there are views that emphasize the role of the early enculturation in the realization of musical potential (Welch, 2005). In other words, everyone has some level of musical capacity; the crucial issue is, in which way and to which extent it is used and refined. This view implies that the opportunity to learn music should not be restricted to those who have passed an admission test, since music belongs to everybody.

The reasons for beginning music studies and the outcomes of musical training have been discussed in research literature. Researchers have found that reasons for engaging in music studies are aesthetic enjoyment and relaxation (e.g., Juslin *et al.,* 2004; Sloboda *et al.,* 2011; Sloboda *et al.*, 2001; Thayer *et al.,* 1994; Van Goethem *et al.,* 2011; North *et al.*, 2000). Emotional understanding is crucial for enjoyment and relaxation; nevertheless, even if it could be thought that purposeful (professional) musical training would increase the emotional understanding of the contents of music, a straightforward effect might not be due to musical training. Some studies even report neural responses associated with affective processing in non-musicians, but not in musicians (Müller *et al.,* 2010). The emotional understanding of music can also grow if a person becomes an "expert listener" through daily exposure to music (Bigand *et al.,* 2006). Consequently, music education should also encourage intelligent and versatile listening habits and an active search for music that touches one's emotional and aesthetic senses.

Concerning the beneficial results from engagement in music activities, in addition to musical abilities, the following skills are mentioned: "literacy, numeracy, intelligence and creativity" (Koutsoupidou *et al*., 2009); "concentration, self-confidence, emotional sensitivity, social skills" (Broh, 2002) and "team work, self-discipline, and relaxation" (Hallam, 2010). Musical activities in early childhood seem to benefit the development of perceptual skills and rhythmical exercises seem important for literacy skills (Hallam, 2010; Piro *et al*., 2009; Moreno *et al*., 2011). Learning to play an instrument may improve spatial reasoning, one aspect of general intelligence that is related to some of the skills required in mathematics (Norton *et al.*, 2005; Shellenberg *et al*., 2007; Haley, 2001). After their research Rauscher *et al*., (2011) concluded that rhythmic training is important for the development of temporal cognition while skills related to pitch and melody support language development.

Whatever the reasons for engaging to music studies and other activities, the professional music teaching follows the guidelines stated on the basis of legislation and the firm experience of instrumental pedagogy from hundreds of years of modern face-to-face education. New views highlighting the creativity and self-

directed learning strategies of the students are little by little emerging in the everyday classroom teaching and in the updated guidelines for teaching and evaluation in instrument education as well.

1.3 The contents of the examinations and bases for evaluation in violin basic education

The guidelines for violin education (The Association of Finnish Music Schools, 2005) follow the spirit of the extensive curriculum of music: teaching should arouse a good relationship and enthusiasm with music and support the music students in finding their own musical identity. Self-confidence and using one`s whole capacity should be strengthened by the feeling of success after long lasting practising of the repertoire and refinement of the performance. As a general view, the violin students should learn independence and regular practising routines. To give the examination situations a closer connection to living music life, the examination programmes should, if possible, be performed in a concert situation. In addition, chamber music can also be part of the programme in the examinations. After the examinations the students are given both spoken and written feedback and the evaluation should be supportive and constructive and encourage the students principally to set and achieve their own goals.

In the legislation considerable freedom, especially concerning the programmes to be learned, is allowed for both the teachers and students. At the first stage in music school studies the appropriate playing position, understanding the musical content, and the quality of playing is emphasized: the violin students should find a natural style of playing and create the character and atmosphere of the music, find good sound, intonation, articulation, phrasing and dynamics and also perceive simple musical constructions. The basic techniques of bowing should be learned at the first stage: changes of speed and the use of the whole bow. In addition to learning new compositions from printed scores, the violin students in the first stage should learn to play by heart and by ear.

On the second grade the personal style of playing is being refined; the same elements as in first grade are developed further and the repertoire should include a larger variety of styles. Concerning the left hand technique, crucial elements concerning string instrument playing are in the education program: playing in and changing different positions, the basics of vibrato and chromatics, preparatory exercises for bowing styles like: *staccato, sautille, spiccato and ricochet*. There should be a larger range of music from different eras and styles: Finnish music, modern music, and also compositions which contain passages in different style and atmosphere.

The creative aspect is also highlighted in the guidelines for violin education: the students should be encouraged to improvise on a theme, motif, or harmony base, and make their own music. Students` own compositions and improvisation

performances can also be included in the examination program. The guidelines give tools for versatile education of gifted and musically talented children to become active members of community musical life and to find their identity as human beings. The teachers have an important role in developing the learning environment in such way that it supports learning for different kinds of individuals as learners. (The Association of Finnish Music Schools, 2005.)

1.4 Orchestra and play-together education in music schools

Playing together is viewed as an important subject in music school instrumental education. Taking part in different kinds of orchestras and groups on the appropriate technical level and with varying music styles is considered to best support the musical and social development of music students; they learn to work with other players in a positive and responsible way and gain feelings of self-confidence, security and safety when playing together with their mates in rehearsals and concerts. In addition, reading scores can naturally be integrated with orchestra and other kinds of playing together education especially at the early stages of music studies (Finnish National Board of Education, 2002).

In most music schools playing together is started from the very beginning of children's instrument teaching to ensure that the students adjust to playing with other children and it is continued throughout all the studies in the music institution. With playing together the students learn social skills and responsibility in a natural way; they learn to take care of their instruments and other belongings, both their own and those of other players (The curriculum of the Conservatory of Kuopio). In addition, the orchestra players want to play their scores properly because they don't want to destroy the playing of others and the orchestra thus, their responsibility and motivation to practice at home will be reinforced as a result of being a member of a music making group.

In the *extensive curriculum of music education* the skills to be learned in playing together have been stated in some curricula of music institutions. In The curriculum of the Conservatory of Kuopio (25.3.2014) the skills to be learned on the basic stages of music learning are stated quite specifically: *the student hears and recognizes musical phenomena and reacts to them in a group in harmony with the style of the music, is able to interact with the group, acts cooperatively and responsibly as a member of the group, acts actively and initiatively for the group and is decisive and reliable* (The curriculum of the Conservatory of Kuopio, 2014).

In most music schools, the regular rehearsals of the orchestra or chamber music groups are supervised by a teacher or a conductor and usually run once a week; performances and concerts occur three to four times in a semester. For a productive orchestra activity with a large enough repertoire in varying music styles, it is crucial that the students practise their parts at home. Nevertheless, the

quality and strategies used in home practising are more important than the amount of time spent. Although most scholars agree that formal practice time plays an important role in musical achievement, empirical investigations have failed to show consistent associations between practice time and achievement. Bonneville-Roussy *et al*. (2014) suggest that quantity of time is not the most crucial element in appropriate practising and that "practice should be defined as a goal-directed and focused period that includes both self-regulation and deliberate practice strategies" (Bonneville-Roussy *et al*., 2014).

Accordingly, repeated goal-directed practising at home with good strategies is essential to orchestra activity in music schools. According to Vartiainen`s research (1995) on Finnish orchestra students, their attitudes towards playing together, orchestra conductors and the music repertoire of the orchestra are positive. Students meet their orchestra peers willingly and they say that they do not find their public performances as stressful as their solo performances. The students note that in orchestra rehearsals they learn to listen to each other and improve their social interactions. Furthermore, they improve in reading music scores, keeping the pulse, generating nuances and perceiving the larger picture of a piece of music. Nevertheless, only half of the students practised their scores at home. (Vartiainen, 1995.)

An essential question concerning motivation for home practising and prolific orchestra activity is its repertoire: the music to be learned should be interesting and nice to play; it should "sound good". The different parts of the score should fit the students' playing skills: if the music is too easy, playing is boring; if too difficult, the music can be frustrating for the students. All parts of orchestra or chamber music scores should have some attractive ideas and they should be idiomatic and natural for the hands. Nevertheless, a second violin score, for instance, may be more difficult to read and figure than the etudes which the students learn in instrument lessons.

Although as a play-together teacher, I have found good practices to teach the students in face-to-face orchestra and chamber music rehearsals, I have faced problems concerning home practising. How can the second violin or violoncello players find motivation to practise their scores? How do students know that they play correctly and get support at home if no one in the family can read the scores? Accordingly, following the ideas of the extensive curriculum (the Finnish National Board of Education, 2002) I think that it is up to the teachers that have close contact with students and professional expertise on the subject in order to create learning environments that motivate the students to work in the classroom and at home to learn musicianship skills and creative attitudes for their life.

In the following sections research and discussions on learning environments, roles, interactions and strategies of teachers and students are described; the significance of self-efficacy of students, apprenticeship versus self-directed learn-

ing strategies in string instrument playing, and the boundaries between formal and informal learning are also explored. In addition, using the Internet, social media and portable devices in learning are also studied. Finally, the new views concerning education environments that are gradually being issued in Finnish music education are reviewed.

A well-known system of distance learning of the violin is described as a successful result of developing music education technology in Finland. It seems to me that blurring of the boundaries between traditional and new ways of viewing educational aims is the challenge to be faced recently, but I also emphasize that the changes should be based on sound pedagogical principles and research on the impact of new models to be chosen.

Accordingly, this thesis describes a new blended learning environment in which not only the traditional tools and methods but also technology is used for teaching students to play better on the basis of a deeper understanding of the musical content. This has been accomplished by using aural strategies: playing with the support of an audio background of the music, with a method called the *Playback Orchestra* method. The learning strategy in the method is flow-like: playing and dropping, and taking hold of the ongoing music again. A philosophical, but crucial goal for using the method is that by participating in the flow of the music an *optimal experience* of playing music, called *flow* by Csikszentmihalyi *et al*. (1992) can be reached in a natural way.

2 Basis for the research

Throughout the history of learning to play or sing, teaching has been face-to-face tutoring in a classroom. Instrument education methods have been created through expert musicians and pedagogues teaching musically talented students and some crucial elements that lead to successful learning include: the expertise, methods and personality of the teacher, the potential of the student to adopt the education and the learning environment in and out of music classroom.

The aim of experienced and insightful teachers is to make themselves more or less unnecessary; students should become gradually self-directed executors of their own learning on the basis of their history as music students. However, at earlier stages of studying, authority is a crucial resource in the teacher-student interaction and according to Nerland *et al*. (2002) such dominant authority is not only accepted, but also desired and even sought after by the students. Because both students and teachers must expose themselves emotionally in the educational processes, they grow closer to each other on a personal level (Nerland *et al.,* 2002, 180).The personality of the "master" may also be described as a source of inspiration for the student (Jørgensen, 2000) and the presence of a "master model" is a powerful, universal motivating force (Uzler, 1992, 584).The instrument teacher may also be the key person behind the later decision to choose music as a profession (Hirvonen *et al.,* 2000; Ruismäki 1991, 1996; Kosonen 2001; Broman-Kananen 2005). Because the students` own teachers know intimately their state of personal and educational development, their strengths and weaknesses from the close contact after many years of study together, face-to-face learning supports students` developing as sovereign personalities with sound self-respect and knowledge of their own capacities.

In addition to mastering their own instrument, instrument teachers are also expert pedagogues who organize the lessons with deliberate consideration. Research literature shows that expert teachers arrange instruction in hierarchical sequences composed of small, attainable steps that lead toward accomplishment of clearly defined goals (Buckner, 1997; Siebenaler, 1997). Music lessons and rehearsals are structured in time: according to the study of Colprit (2000), approximately 45% of the total time is devoted to teacher talk, 20% was devoted to teacher modelling and 41% was devoted to student performance. Duke (1994) has proposed that segments of instructional time devoted to the accomplishment of identifiable instructional goals, "rehearsal frames", can be observed as units, within which the teacher works to accomplish positive change in student performance. A rehearsal frame begins when a teacher identifies an aspect of student performance that needs improvement and ends when the specified goal is

accomplished. Colprit (2000) also found that expert string teachers more frequently described targets in terms of a musical result (e.g., tone) than in terms of a physical behaviour (e.g., motion of the bow); in other words, they were more concerned with the musical content than the playing actions. Across target categories, teachers addressed intonation most frequently, followed by bow distribution (frog, middle, and tip), bow contact (weight, angle), tempo, rhythm and style/articulation.

Good practising routines are crucial to students' successful music learning. As Williamon *et al*. (2000) state, achievement in any area can be affected by the amount and quality of deliberate practice, a routine of purposeful and focused activities used to develop and gain proficiency in a certain skill (Williamon *et al*., 2000). Regarding music education, research has shown that the way students practise, how much they practise and even when or where they practise may be related to musical achievement (Woody, 2001). According to research by Csikszentmihalyi *et al.* (1993), those who were considered talented in certain skills were able to focus and work with higher levels of sustainability, while, at the same time, demonstrating an understanding of balance in their activities; they set goals appropriately and had environments that allowed them to be successful, such as more time to practise and study rather than working part-time jobs or socializing excessively (Csikszentmihalyi *et al.,* 1993). While examining the relationship between success and various other factors (i.e., amount of practice, strategy techniques or even anxiety issues), researchers (McCormick *et al.,* 2003; McPherson *et al.,* 2006; Clark, 2008; Schulz, 2005) found self efficacy (the awareness of determined effort and planned persistence involved in succeeding at a particular task, skill or subject) to have the strongest correlation with aural learning strategies.

Cahill-Clark (2013) studied how the behavioural and strategic aspects of deliberate music practice occurred in students with high string-playing self-efficacy. The student with the best results had an exceptional instrument, worth far more than the instruments of his peers in value; his motivation to practise was much more than average and practice was more important to him than his academic studies. Furthermore, the support of his family was beyond the norm for a young high school student. His private teacher was truly an expert, a principal player in a major orchestra and a professor at the local university. He focused on very specific and advanced musical techniques or approaches. Some of these skills included: varied and continuous vibrato; smoother and more clearly executed shifts; intonation affected by distribution, control and weight of bow rather than just the left hand; constant metronome use and rhythmic accuracy, incorporating both springy and rebalanced left fingers from the base of the knuckles; and finger agility in the right hand to control articulation. In the current study, the one student who waited to practise until 'she had time'. late in the evening, was not the most successful student and had the lowest musical self-

efficacy. The learning strategy of the most successful players aims at fixing and adjusting *larger sections* and going back after playing through to the details. (Cahill-Clark, 2013.) In past research, this has been found to be a higher level practise strategy (Hallam, 1997; Clark, 2008).

The educational strategy of instrument teachers has traditionally been based on apprenticeship in which students practiced under the supervision of an experienced master of the discipline, imitating the play activities of their teachers. A commonly assumed feature of musical apprenticeship is using demonstration and imitation (Burwell, 2013; Polanyi, 2012; Callaghan, 1998; Bruner, 1996). According to Jørgensen (2000, 68), the *master* is expected to demonstrate a high level of expertise and "gains prominence by virtue of outstanding musical skill" (Persson, 2000, 25). Accordingly, students are linked directly to a teacher of their main instrument who is a professional musician at the highest level. Interaction with their teacher gives students the opportunity to "*observe and participate* in profession-related activities, thus providing them with access to crucial knowledge and standards of the discipline" (Nerland *et al.,* 2002, 168-169). Nevertheless, there is also some resistance about imitation as a core mode of learning; to copy one`s teacher is seen as embarrassing because individuality of interpretation is highly valued in musical performance, particularly by the time students have reached the level of higher education (Nielsen, 2006, 9; Mills *et al.*, 2003, 9; Nerland, 2007, 409). However, it cannot be denied that certain aspects of playing technique can be learned in no other effective way than imitating (or copying) a model: accuracy of rhythm, bowing technique, vibrato, and ornaments are all improved by imitation. Vygotsky sought to distinguish imitation from copying: "imitation is possible only to the extent in which it is accompanied by understanding" (Chaiklin, 2003, 51-52). Thus conceptualized, imitation is part of a collaborative process with the more expert other player (Burwell, 2013). The students and teachers build the technical and interpretational resources through mutual interaction that is supervised by the teacher.

Nevertheless, Sloboda *et al.* (1996) noted that the most able young musicians tended in formal education situations to spend a considerable part of their time in "informal" music making: playing by ear, playing "fun" music from books and improvising. These activities clearly added to their enjoyment of playing and at the same time increased their musical experiences and broadened their knowledge base and music vocabulary. Accordingly, improvising is thought to offer pupils a creative space within formally structured music education; during these moments they can explore their own ideas and develop autonomy in the "master-apprentice" pattern of most one-to-one instrumental lessons (Rowe, 2015). Allen (2013) found that pupils who had reported experiencing performance anxiety were more anxious when performing a repertoire piece than when presenting their own improvisation in front of an audience.

Recently, new ways to learn music have challenged the traditional teacher-centred methods and strategies. The rapid development of music technology in recent decades has dramatically changed the way people interact with music today (Dittmar *et al*., 2012) and the Internet has presented a new learning environment for music learners (see Bauer *et al*., 2003; Ho, 2004, 2007). Music and music making is increasingly taking place in the field of informal learning (see Waldron, 2009; Salavuo, 2006, 2008) and learning through social media where peer learning is one part of the learning process (compare Lebler, 2008). In addition, social media can also be used within the music classroom and it is even possible to allow parents and students to connect with the teacher`s musical content through the *Sound Cloud* (Lebler, 2008). With this kind of enlargement of the classroom, the role of teacher is gradually changing from a "lecturer" to a "coach"; the learning style is transitioning from teacher-centred to student-centred and the learning strategies have *learning-by-doing* features.

Due to the recent developments in portable devices like smart phones and tablets with higher processing power, more powerful audio-processing features and visuals that are more appealing than a short while ago (see Ho, 2007; Georgii-Hemming *et al*,. 2010), the learning environment has moved outside the physical classroom. Researchers have stated that the advent of mobile learning opens the creation of new social practices in learning (i Sole, 2009) and game-based learning will be a trend within a few years (Leong, 2011). Pachler (2009) stated that mobile learning is slowly establishing itself as a field in its own right and Chen (2015) stated that one consequence of the changing paradigm of teaching and learning musicianship skills would be to change the role of music teachers' education more to the direction of mobile learning or cloud computing.

For good reasons the Internet and online learning are viewed as an opportunity, but they are also a challenge for traditional music teaching. The administrators, teachers and students in music institutions have faced the problems of evaluating new systems, learning new methods and new ways of interacting more closely with each other. The new views concerning education environments are gradually being issued also in Finnish music education. For instance, a few years ago Matti Jordman, chief of the Sibelius Academy Innovation Centre, stated in an interview (Pietilä 2007) that although overly innovative projects should not be implemented in music classes where creative activation is most important, still, through a net-based course students could practise basic "bulk" skills, which could later be further refined in the classroom. (Pietilä, 2007.)

2.1 Blurring the boundaries between informal and formal music education

One of the most outstanding changes in culture made possible by technology is the large number of net communities (Partti, 2012, 71). Partti's research (2012) questions the sharp division between highly specialized musical expertise and amateur music making, as well as the divisions between different musical styles and genres, and the various roles of music makers. Communication and an exchange of musical ideas, characteristic features of digital musicianship, provide individuals with the access needed to use their intelligence more freely for musical growth and expression and to share in the values of musical cultures more democratically (Partti, 2012). According to Partti, the web community resembles band activity: composing pieces as a group.In the case of web community, the group is larger due to technology and it is typical that "the journey is more important than the goal"; the ready-made product is not as important as the process itself with its experimentation and playful sound trials (Partti, 2009, 45). Partti continues:"Nevertheless, while informal music practices represent essential aspects of our society's community life, they do not necessarily represent ideal models for the music classroom" and further, "it is essential for music educators to pay heed to music making inside and outside school, as well as in the whole continuum between the formal and informal poles" (Partti, 2012). Accordingly, Partti asks, how can learning environments be built where the teacher is not the only expert, but the students also benefit from each other as specialists in their own growth (Partti, 2009, 45).

The new generation of learners has been called most widely *digital natives (*e.g., Prensky, 2010; Bennett *et al*., 2008, 2010; Crappell, 2011). They are usually youngsters, who "come from a media-rich household, who use the Internet as a first port of call for information, who multi-task using Information and Communications Technologies and the Internet to carry out a range of activities particularly those with a focus on learning" (Helspner & Eynon, 2010, 515). Internet users share online media content they had created *themselves*, making a flexible use of technology in self-expression, socialising and learning (e.g., Salavuo, 2006; Gallant, Boone & Heap, 2007; Lomborg, 2009; Waldron, 2009). Music making and learning is enabled by technology and accomplished by members of participatory culture which is a collection of ever changing *digital habitats* (Wenger *et al.,* 2009, 38). Members of that participatory culture believe that their contributions matter (Partti, 2012). Wenger (1998) describes the new situation of feeling oneself at home everywhere and nowhere and having the capacity to utilize this "rootless" state to open up "new possibilities for meaning" (Wenger, 1998, 109) forms the basis for *cosmopolitan* musicianship,

which means a tendency to assemble communities wherein differing views on musicianship exist simultaneously.

Learning music in the participatory culture of digital habitats is based on the participants' active creation and production of media artefacts, rather than by the utilisation of ready-made content by so-called experts. Digital musicians' work emphasizes using digital technologies in making music in a home studio with virtual instruments, distributing one's music freely to others in online communities, remixing music of one's peers and one's idols online, taking part in conjoint web-based musical projects, DJ'ng, or even processing further one's personal computer or mobile devices (Väkevä 2009, 30).

In some Finnish net communities concerning music through this millennium, such as *mikseri.net*, one can listen to, download and judge Finnish music, add countless pieces of music, create one`s own artist page, gather judgments and fans (mikseri.net). According to Salavuo (2005) *mikseri.net* is an informal learning environment making possible for young people to learn in harmony with their own needs and goals. The pages do not teach; rather, they help to create a community that supports learning, getting information and users benefit from the knowledge and experiences of people who are specialists in different areas (Salavuo, 2005). Taking part in the activities of a web community also makes one's own learning and skills observable (Salavuo, 2013). Wenger (2006) concludes: "We need new visions of what is possible. We need new models to learn how to learn at multiple levels of scale, from the personal to the global" (Wenger 2006, 1)

Although the global surroundings seem to grow smaller, as Wenger (2006) points out, our *awareness* of the environments grows ever wider (see also Webster & Mertova, 2007). Further, Keith Sawyer (2007, 37) paints a picture of an "innovation economy", a society that relies on people's ability to work together in order to create novelty, acquire new competencies and break through the boundaries of earlier knowledge and competence in ever more competitive and unpredictable environments (see also, Paavola *et al*., 2005).

According to Hugill (2012), one can simultaneously be highly skilled and experienced in one aspect of the culture (e.g., computer programming), while just a beginner in another (e.g., playing an instrument). Along the same lines, Partti (2012) states that people with different musical preferences and in various age groups and levels of expertise should learn and make music together; furthermore, she suggests that student's earlier informal learning experiences should be taken into account in order to make formal music education meaningful in students' lives (Partti, 2012).

According to Giddens (2002), we are fundamentalists (who are one-sided and lean on traditional views) or cosmopolitans (who tolerate differing views) depending on our capacity to cope with diversity. Fundamentalism is based on the notion of "only one right and proper way of life" that is often tightly con-

nected with traditions and a pursuit of constancy and single-mindedness. Following this model of teaching, the "master teacher" knows goals and how they should be attained and the task of the adult and expert is to demonstrate how to 'do it right'. In the apprenticeship model of teaching, the teacher is the *initiator* and *verifier* of activity (Westerlund, 2006, 120, emphasis added by Partti).

The ideas of participatory and mutual learning often seem to be problematic for traditional and conservatoire based music education, which has a long history of firm belief in the superiority of the teacher's authority and knowledge as the starting point of successful educational practice (Westerlund, 2009). In fact, the traditional apprenticeship model of teaching might even view the development of expertise through participatory learning and using collective intelligence as a threat, not as an app to a learning environment. However, it is important to note that whereas traditional approaches to music education have concentrated on producing self-sufficient problem-solvers who skilfully apply "practice-specific knowledge" (Elliott, 1995, 55) and aim for musical authenticity, the need for workers who are able to navigate in rapidly changing settings, draw upon "different sets of expertise", collaborate in problem-solving and break rather than maintain conventions (Paavola & Hakkarainen, 2005; Wenger, 2006; Davidson & Goldberg, 2010;Tolvanen & Pesonen, 2010) will probably also be increasing in the educational field.

Blurring of the boundaries between traditional and new ways of viewing educational aims and tools is the challenge to be faced recently. Paavola *et al*. (2005) remind us that without *creative troublemaking*—the ability to question and problematize existing ways of doing things—one is not likely to be able to cross the boundaries of prevailing practices and will settle for passively following in the footsteps of previous generations instead of actively creating new practices. In this recent situation, mirroring the ideas of Sawyer (2007, 56) it is important to find just the right amount of structure "to support improvisation", but not so much structure that it "smothers creativity", which, according to Sawyer (2005, 5), "rests in introducing novelty in the form of a new musical idea, while remaining consistent with what has come before". In fact, according to Rainio (2010), there is a growing interest in "alternative pedagogical projects that celebrate creativity and playfulness in areas that cannot be measured in traditional ways" (Rainio, 2010, 27).

One crucial aspect of education is the blurring of the boundaries between play and work. Learning, improvisation and creativity should also be seen as taking place within everyday activities [of musicians and music students] and as a basic human function" (Nilsson & Folkestad, 2005, 24). The role of the teacher in educational practices that operate at the junction of control and creativity is crucial in establishing "the right conditions for inspiring, inculcating, and guiding the development of socialized intelligence" (Woodford, 2004, 6), and rather than telling students *what* to think, the teacher should instruct in *how* to think

(Woodford, 2004, 6). The teacher should strive to promote music education that is based on "a cooperative engagement between teachers and students" and learning that is "experimental, mutual, historically engaged, socially responsible, and forward-looking" (Allsup, 2010, 10). Partti (2012) states that "designing classroom practices that promote musical play in which the students' musical creativity is taken seriously, provide opportunities for creating space for dialogue between the students and teachers". Partti continues further: if educators find themselves feeling too comfortable with the *status quo,* they should feel worried". Today's challenges cannot be addressed with yesterday's perspectives, as pointed out by Wenger (2006). As the world keeps changing, so should educational practices.

Recently, online elements have increasingly been combined with the traditional, face-to-face education systems. The general concept for learning environments, which combine traditional face-to-face learning with getting information from outside the classroom situation is *blended learning.* In blended learning, the online, (also called distributed) methods are generally used in a classroom situation and/or supervised by teachers. If the online component is applied outside the classroom, more or less unsupervised, the system is called a *flipped classroom* (FC). In a flipped classroom situation, the detailed information has been acquired independently by students beforehand and is further deepened during the lessons.

2.2 A blended learning environment

Traditional education in music schools typically occurs in a teacher-directed environment with live, synchronous, person-to-person interaction. On the other hand, there are so-called distributed (computer-mediated) learning systems that emphasize self-paced learning that takes place asynchronously outside the classroom. Recently, the face-to-face traditional classroom teaching is being connected to distributed learning and these systems are called blended learning (BL). There have been various attempts to formulate a definition concerning BL; some of them are quite broad such as that of Staker *et al*. (2012): blended learning is "any time students study at least partly in a supervised situation away from home *and,* in addition, partly through online delivery controlled by the students themselves over time, place, path and/or pace". The most commonly-used definitions are connected with the media by which the education is delivered (Bersin, 2003; Orey, 2002; Singh *et al.,* 2001; Thomson, 2002) and the instructional methods (Driscoll, 2002; Rossett, 2002) reflecting the debate on the influences of media versus method on learning.

According to Graham *et al.* (2006) these definitions suffer from the problem that they define BL so broadly that they encompass virtually all learning systems. Graham *et al.* (2006) prefer definitions that reflect the historical emer-

gence of blended learning systems (Reay, 2001; Rooney, 2003; Sands, 2002; Young, 2001). Following this line, BL can be seen as the combination of instruction from two historically separate models of teaching and learning: traditional face-to-face learning systems and distributed learning systems. These definitions also emphasize the central role of computer-based technologies in blended learning (Graham *et al*., 2006). The trend towards blended learning is increasing and "it seems that this phenomena is here to stay" (Graham *et al*., 2006).The growing of separate education environments into blended learning environments is described in Figure 2.

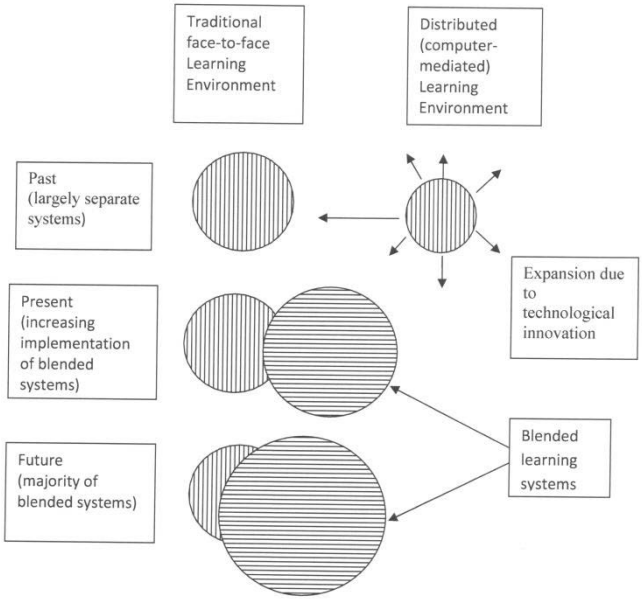

Figure 2. Progressive convergence of traditional face-to-face and distributed environments allowing development of blended learning systems (Adapted from Graham *et al*., 2006)

According to Bonk *et al*. (2002), blended learning combines "the best of both worlds" by integrating formal classroom learning and informal learning, seeking a balance between flexible learning options and the touch of human interactive experience. Some researchers have stated that the blended approaches increase the level of active learning strategies, peer-to-peer learning strategies and learner centred strategies (Collis *et al*., 2003; Hartman *et al.,* 2000; Morgan, 2002; Smelser, 2002). According to research, when becoming experienced in web-supported learning, the students have been found to be more satisfied with the peer collaboration than lecture-based learning (Frederickson *et al*., 2005; Crouch *et al*., 2001).

In a meta-analysis designed to compare learning outcomes of fully *online*, fully *face-to-face* and *blended* learning conditions, Means *et al*. (2009) found that it is "getting more learning time, different kinds of learning activities and access to qualified instructors for learners in places where such instructors are not available" that encourage learners to find blended learning environment victorious over purely online or purely face-to-face learning. (Means *et al*., 2009.) Access to learning is one of the key factors influencing the growth of distributed learning environments (Bonk *et al,* 2002). There is also a significant return on investment, mostly due to an opportunity for reaching a large, globally dispersed audience in a short period of time with consistent, semi-personal content delivery connected with a blended learning style (Bonk *et al*. 2002). Although the ever widening use of mobile learning is becoming customized learning (learning at your own pace on the level the learners feel good), there are many issues to be considered: increased demand on instructors` time (Hartman *et al.,* 2000), providing learners with technological skills to succeed in both face-to-face and distributed environments and changing organizational culture to accept blended approaches (Hartman *et al*., 2000). Ruippo (2015) remarks that in the future, web-based teaching will be a natural part of learning and the distinction between face-to-face teaching and web based teaching will be made redundant. He further suggestions that web-based music teaching changes pedagogy in a way that emphasizes the teacher's role as an instructor or guide (Ruippo, 2015).
The general view of learning environments is shown in Figure 3. This figure is based on figuring learning environment in or out of the classroom and also on whether the learning is supervised or unsupervised.

In Figure 3, the FACE-TO-FACE LEARNING box on the left describes the (theoretical) situation in which the education is delivered exclusively in a classroom by a teacher who provides information and homework to be done and controls the learning with examinations. According to researchers, the traditional model of teaching in the individual instrumental lessons is characterized by a teacher-dominated transmission of knowledge (McPhail, 2010; Daniel, 2006). The traditional music school lessons with person-to-person interaction belong to this "box", if no online elements are used for getting information, scores for example or if no computer-assisted methods are used during the learning situation.

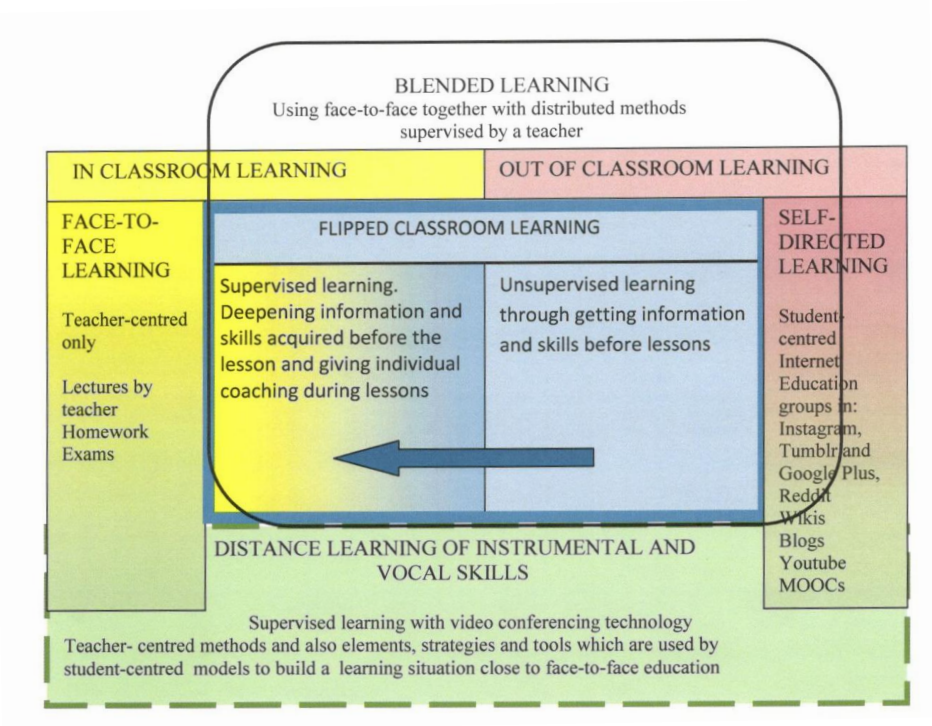

Figure 3. Learning environments in music education

The SELF-DIRECTED LEARNING box on the far right indicates the opposite situation: learning music with the Internet or other tools with a strategy in which the role of a teacher has diminished or faded away: student-centred systems. The middle part describes blended learning and the blue area inside it, the FLIPPED CLASSROOM, which implies that the detailed information on the subject to be learned is acquired by the students beforehand to be dealt and deepened in a classroom situation. The flipped classroom learning environment can be seen as basically the same as a traditional music learning situation, in which the detailed information of the music to be learned is practised at home and the performance is refined during the lesson with the supervision of the teacher. The learning activities outside classroom can be considered as "student centred", whereas the lessons supervised by teachers are "teacher centred" learning environments.

2.2.1 The Flipped Classroom: A student-centred learning environment

The idea of a learning environment called a *Flipped classroom,* known also as the "inverted classroom", (Milman, 2012) was born from the need to save precious classroom time for deepening the knowledge of the subject with conversa-

tions and supporting all the students by individual help during the lessons, giving time to help the students who have dropped behind and letting the smartest go on at their own speed. The valuable time that is spent together with all students is not used for listening to the teacher deliver basic facts, but rather finding out the answers together and applying the information when solving the problem (Phillips *et al*., 2014; Bergmann & Sams, 2012; 2014).Thus, the role of teachers is changing from being lecturers to coaches: guiding students more individually during lessons.

A simplified, joyful description of a "flipped" classroom by Bergmann *et al.* (2012) is that "The professor's lecture is delivered at home and the student's homework is done in class". Accordingly, the roles of classroom and home have been "flipped"; the students get the information and the teachers make them work on it. Tucker (2012) describes Bergman's thoughts: "In the Flipped environment it was possible to spend more time during lessons with struggling students, and the advanced students had more freedom to learn independently at their own speed". An example of a flexible attitude is described by Slomanson (2014): "I *require* my students to web surf during class. Before flipping, I was not walking around the room, now I also visit students who never ask questions. They especially welcomed the opportunity to privately communicate with the instructor on multiple occasions in each class."

The traditional teacher-centred models focus on the acquisition of knowledge through lectures, homework and exams for assigning grades (Huba *et al.,* 2000). In student-centred learning the learners are active executors in getting the detailed information and learn more authentically by doing (hands-on activities) than in the traditional class situation; they build mental models based on what is learned, deliberately test the validity of those models and fix faulty models (Michael, 2006). Students can also help each other, a process that benefits both the advanced and less advanced learners (Rosenberg, 2013) and the research results of Huggings *et al*. (2015) show that a *team-based* group in a sociology course learned better than the *lecture group* oral communication, creative skills, critical thinking and they also learned to know their professor and classmates.

According to Rosenberg (2013) flipped education is still in the early stages and much experimentation is needed about how to do it in a good way. Moreover, flipped educators as well as technology-using music teachers (see Manninen, 2003, 27) need enough time to create or select homework materials that are most relevant for a particular lesson, such as self-recorded video lectures and screen casts, a set of guiding links or a variety of open educational resources (Johnson *et al*., 2013) The videos or screen casts are made available for students to access as many times as they like, enabling the students to come to class better prepared (Musallam, 2010). By this procedure "lower levels" of learning are moved to outside of the classroom and during the lessons the teacher and stu-

dents can focus on the upper levels of deepening the subject study (Marshall *et al,* .2013; see also Pietilä, 2007).

A substantial body of research on student-centred systems like flipped classrooms supports their effectiveness (e.g., Prince, 2004; Michael, 2006). It has been found that learning by watching videos is a good method for students who do not ask questions in class because they are worried that they will look dumb (Rosenberg, 2013; Horn, 2013). According to research, pre-training (information acquired beforehand) may help in managing the cognitive load during the lessons and this explains the good results in flipped learning (Musallam, 2010; Ayers, 2006; Mayer, 2009). Although assessment findings demonstrated that less lecturing can actually lead to more effective learning, Warter-Perez *et al.*(2012) state that it is important to find a balance between lectures and other such learning components as in-class projects, discussions, real-time assessments and interactive exercises (Warter-Perez *et al*., 2012).Nevertheless, flipped classrooms may not be always the best choice for learning of all subjects, especially in the early stages of a course (Strayer, 2012).

Ferreira-Meyers (2015) notes that although the students may have unequal access to technology, there are many alternative ways to deliver instruction digitally. The simplest method is to download the material to a memory device that can be plugged into a home computer. Video lessons can also be made available via Smartphones, which are increasingly ubiquitous. Similarly, parents who have iPods or iPads can set up a free iTunes account and students can then subscribe to receive the material. Further, teachers can burn lessons onto DVDs that can be viewed on computers in the school or public library or at home. In addition, schools can make computer labs available after school hours. (Ferreira-Meyers, 2015.) With the advancement of technology, the e-aural book is suggested in the mode of blended learning which means that the teachers can monitor the progress of learning of each student through cloud technology to adjust the teaching strategy in the process of learning (Chen, 2015).

Because new education strategies challenge the instructors' skills in online teaching, it has been found that teachers need to improve their ICT abilities (Alzahrani, 2014). The challenge in today's schools is how to make environments that equip the students with 21st-century skills and capacities. Global awareness, creativity, collaborative problem solving and self-directed learning are some of the most important skills for the future and learning environments can have an important role in developing them (Groff, 2013; Groff & Mouza, 2008; Yelland, 2006; Hannafin & Land, 1997; Riel, 1994). Further, it seems that today's students, who are digital natives (Prensky, 2001) prefer new ways of learning in different kinds of learning environments that allow teachers and students to adopt new kinds of behaviour consistent with the realities of a rapidly changing technological society (McGhee *et al*., 2001).

According to Lajoie and Azevedo (2006), technological adds in teaching and learning should always be designed based on a theory or model of learning and instruction and meet the needs of learners. In the broadest sense, the term 'technology-based learning environment' means the use of ICT in teaching and *studying* (Manninen *et al*., 2007, italics by Juntunen). Technology-rich learning environments provide places to learn, teach and also dynamically collect data about the learning process. Lajoie and Azevedo (2007) state that these kinds of platforms can provide opportunities for students to explore material that they would not be able to reach in the regular classroom.

Technology is inevitably one of the main agents of educational change today because it has the potential to facilitate students to engage in interesting learning contexts. According to McGhee *et al.* (2001), technology's most important task is to provide students with tools and information that support their problem solving, communication, collaboration and knowledge creation. Effective use of technology usually requires substantial changes in classroom routines and that can produce anxiety and concern (Bitner *et al.,* 2002); this transformation does not happen overnight. Both students and teacher need to have time to adapt to these new practices and adopt their new roles (e.g., Rasmussen *et al*., 2010).

In many cases teacher educators do not know how to use the technology or teach about it; accordingly it is fine that their students have an opportunity to experiment with the technology-rich learning environment independently (Groff & Mouza, 2008; Bingimlas, 2009; Lawless & Pellegrino, 2007). To familiarize teacher students in using recandent technology-based educational tools and strategies, a learning environment called Minerva Plaza was opened in 2012 at the Faculty of Behavioural Sciences at the University of Helsinki. According to an article by Ruismäki *et al*. (2015), Minerva Plaza is a new, innovative engaging learning environment. It aims at furthering engagement in new and different learning methods, student-centred teaching and learning and the use of different kinds of educational technology. It is an environment where group work, workshops, conferences, lectures and distance teaching have been made possible. The space contains numerous iPads and every room has at least a SMART Board, which makes it easy to have a connection between different spaces of the plaza.

According to Mikko Halonen, the educational technology coordinator of the space, the users have offered suggestions for how to develop the space and its educational technology; they have mentioned what applications to have on the iPads or what kind of furniture could be added to the space (Ruismäki *et al*., 2015).

The Minerva Plaza environment could be useful in the education of student teachers, and Halonen has concluded that

> ...we should teach student teachers, especially primary school student teachers, in this space because they have to have the ability to use different kinds of educational technology in their work. If they don't see

> how they can be used correctly during their studies here, they will have a much more difficult time learning to use educational technology in the field or in their future classrooms. (Ruismäki *et al*., 2015)

Halonen also envisions other uses for the Minerva Plaza: "The space could be used in a more informal way and also more like a laboratory. Maybe it could be more like a cafeteria with little corners where students could try out different ideas. We could bring the companies here, maybe do different projects with them, and invent new ways to utilize the educational technology. We could offer an environment where the staff and the students could create innovations" (Ruismäki *et al*., 2015). Ruismäki *et al.* (2015) concludes his case study concerning Minerva Plaza saying that "technology-rich environments are the learning environments of the future. The fast pace of the development of educational technology brings new possibilities to the field of education, and the use of technology in education will have an important role in providing students with the skills needed in the 21st century (Ruismäki *et al.,* 2015).

Discussing music education, the concept of flipped learning is nothing quite new: in traditional instrument or singing education the students have had an active role outside the classroom when creating their own interpretation of the repertoire and practising the technique for difficult parts of the scores, while the face-to-face situations have moments to deepen the interpretation and get technical practices and tips to be used at home. When well prepared for the lessons, the students can feel safe and enjoy their abilities and sense of control from the teacher. It is clear that in any safe environment a student is better prepared to take the risk of making mistakes than when he or she feels insecure or socially threatened. Considering the orchestra rehearsals, in a sense they include a flipped classroom element *inside the classroom*, as well: the new pieces are first played without preparation ("prima vista"), which is comparable to finding information on the subject (orchestra piece) beforehand; thereafter, the teacher informs them (deepens the subject) with details of the playing style.

In line with the views of the flipped classroom, the music students can load scores, recordings and other material from the Internet and study them before the lessons. They can study the material together with their teachers and choose those most suitable for their use. Traditionally, the scores have been bought from music shops, but nowadays they can be loaded from Internet to be printed at home. There are also pages from which one can get both the scores and an audio of the music, and even Skype lessons on playing the violin can be found.

2.3 The Internet as a source of material for violin studies

When learning new pieces of music, students will do well to following the playing style of the teacher when practising at home. Nevertheless, the students can

get instrument lessons only once a week; therefore, the possibility to get an accompaniment for a solo score to support practising has been used as a resource; it gives the image of the music as a whole: harmonies, pulse, rhythm and articulation. Knowing the whole music gives a good basis for practising; the students will feel well prepared and secure when going to the individual tutoring session with their teachers.

Accompaniment recordings are not new in music teaching, several publishers and record companies have marketed a program known as "Music Minus One" in which the part to be played is muted and all other instruments of an ensemble can be heard as a background for individual playing. This format has been used in the era of C-cassettes, later CDs and recently in portable devices as Mp3 or other compatible file formats. Unfortunately, much of such recorded accompaniment differs in quality from unpleasant machine-like audios to concert level performances. They may sometimes be performed by amateur musicians, resulting in uneven dynamics and overly rigid tempos that are played either too fast or too slow.

The company *Music Minus One* was begun in 1950 and today the pages offer close to nine hundred albums from different eras from Baroque, Romantic and Classical periods in music. In the pages there are 356 pieces for violin: concertos, sonatas, chamber music and film music. The scores together with the CDs are sent by post or email. In the Music Minus One pages, there are violin learning books, classical favourite albums, music for two violins and favourite film themes; all scores are added with accompaniment CD. The music can be prelistened from excerpts, but unfortunately the sound quality of the audio connected with *learning book,* for instance, is poor and the pulse is machine-like. Nevertheless, in the *Classical Favourites* album and most of the other music in the pages there is nice orchestra sound performed in one case by the Stuttgart Symphony Orchestra. The melody part in the CD is played with a xylophone to be better perceived against the orchestra background. In the collections for *two violins* the compact disc uses a split-channel stereo arrangement: the first violin on the right channel, the second violin on the left. By adjusting the balance, the soloist can remove either violin or play the other part. Beethoven`s violin concerto includes a -20% slow-tempo version of the accompaniments for use while learning the piece.

From *AMS Music Shop* pages students can download themed books for beginning violinists in different styles: country music, gypsy, romantic, Jazz, blues and rags. Each book has 10 easy songs, with a total of 50 songs and each song comes with a video performance and tutorial. The books can be printed at home and the Mp3 files listened to at three different speeds on computers or mobile devices: a slow speed for practice, a track in performance speed and also a performance speed including the violin part. *Violin Backing Tracks – Musicroom.com* websites offer sheet music, books about music and tuition books.

The sheets and CDs can be received by airmail in one to two weeks. From the sites *MUSICIANSBACKINGTRACKS.COM* one can download performance packs in Mp3 file format and guiding as video tracks. Sheet music is also included, as far as copyright reasons allow. In addition, one can also buy gift vouchers for Skype lessons from Pete Hartley.

There are also sites for free music downloading, such as *Virtual Sheet Music*. The Mp3 music accompaniment files are created with a computer by using real instrument samples and they are intended for educational and informative purposes only. All accompaniment Mp3 files for the soloist repertoire are available in piano versions with a clear and concise audio metronome. The sheet music is delivered in PDF files and accompaniments in three versions of Mp3 files: a clean full-speed version with two bars of metronome before starting (to lead the player to the right tempo); the same with a metronome with accented beats through the piece, and the third version with a slower tempo (-20%) for practice purposes. An advantage of *Virtual Sheet Music* accompaniment files is their compatibility and portability, allowing practising and performing with any desktop or laptop computer, iPad, iPhone, iPod, or Mp3 player.

Score Exchange pages are the largest online retailer of recently made compositions and arrangements: the pages offer thousands of sheet music scores written with the Sibelius notation program to be downloaded for many kinds of instrumentation. The music can be browsed by instrumentation, composer/arranger, genre, purpose, event, difficulty. It is a very useful webpage for educational use: to listen and print music or to publish one's own compositions and arrangements to be bought or even critiqued by anyone. Wild (2010) strongly encourages string teachers to develop their own teaching materials because the best strategies for teaching might require pieces that are tailor made for their ensembles. The new arrangements can be loaded to *Score Exchange* to be used by other music teachers or students, as well. Further, it is exciting and motivating to see one's music being listened and discussed by people all over the world (Salavuo 2006, 235).

In conclusion, it is easy, quick and cheap to obtain scores and accompanying backing tracks, as far as recordings from the Internet, YouTube and Spotify to be used as extra material for the lessons or as support in home practice. Concerning the online lessons afforded by the web sites mentioned above, Skype is not a very suitable technology in mediating instrument teaching including playing movement because the images are blurry. For online and real-time instruction, the latest teleconferencing technology is a better choice.

When determining which material is good for the students, the teachers have a crucial role as experts in music and education. The teachers also inform the students about the appropriate devices to be used at home, the speakers used, for instance, should be of high quality. Because the tempos of the recorded audios (which have been downloaded from Internet) cannot be changed unstepwise, it

should be considered if using the backing tracks downloaded from the Internet will do more benefit or harm for the studies, especially if the tempo chosen for practising is too fast. A better choice should certainly be the *Avid Scorch* application and iPad together with, say, a Bluetooth speaker with good enough quality. Anyway, it is important to note that the teachers are very important catalysts in evaluating good learning strategies and distinguishing them from those that are unusable, pedagogically worthless or negative. It is easy to mirror the view of Andrew Keen (2007): the Internet can also be seen as more or less bottomless sea of unfiltered information and mediocre art.

In the changing views concerning education, the role of the teacher is changing from that of a "lecturer" to one that is more like a personal trainer. The students find information outside the classroom and on the Internet and the teachers support and deepen the knowledge in the classroom. However, there are instrument learning strategies that are not based on personal tutoring at all; they are instances of learning unsupervised without a "teacher" in traditional sense. Some adult learners may appreciate learning to play without having to be in a classroom with a demanding teacher.

2.4 Unsupervised instrument learning with technology

With the growing educational tool palette afforded by the Internet many, mostly adult amateur musicians have searched for courses for unsupervised learning in MOOCs (massive open online courses). This kind of self-directed learning takes place only remotely and the teacher and student usually meet never face-to-face (Oblinger *et al.,* 2005). In addition to informal learning with MOOCs, researchers, as musicians themselves, have created unsupervised learning programs for home practising: violin tutor systems. These programs have the advantage that the students receive quite instant feedback and information on how to correct their errors.

2.4.1 MOOCs support informal instrument learning through the Internet

Among the most current trends in technology enhanced education are the MOOCs, or Massive Open Online Courses. MOOCs are an effective technology for delivering large amounts of information and courses to be used for free or at low cost for the students. MOOCs were started in 2008 by George Siemens who wanted to provide more learning opportunities to his students and improve their learning experience (Gaebel, 2014). Universities use MOOCs in their education for various reasons: lowering the cost of education; using existing resources more efficiently, e.g. by supplementing traditional classroom education with MOOCs, offering traditional students more flexible learning opportunities or reaching out to new learner groups. Nevertheless, it has been found that in spite of the success of MOOCs as an educational resource, many students drop the courses because lack of time, motivation, feeling of isolation and insufficient technological skills (Khalil *et al*., 2014).

According to Ferreira-Meyers (2015) there are views stating that the first wave of MOOCs was designed by faculties from elite institutions who produced a format that may be effective for the bright self-starter but is unsuited for the average or challenged student; furthermore, the earliest courses took no responsibility for learning results or for the monitoring, engagement, evaluation and accreditation of students (see also Gaebel, 2014). The later generations of MOOCs seem to focus more on the typical student and afford paid credentials and certification for a moderate fee (Ferreira-Meyers, 2015).

Although MOOCs are typically used by higher education institutions, they have been found to be very useful in informal music learning. The first *Play With Your Music* (PWYM) was organized in 2013 with five thousand participants (Ruthmann, 2014b). It has been found that a good strategy is to divide the participants in MOOC courses into groups, in PWYM course on the basis of musical taste (Kahn *et al.,* 2015). There may also be weekly video lectures that can be added with chat conversations (Schmidt *et al.,* 2015).

Although there are well working MOOC practices, many problems remain to be solved, for instance: in fact an outstanding amount of participants interrupt the course, how to adhere all of the participants? How can the course compensate for the lack of human contact, how can the courses be evaluated so that they are more appreciated in the labour market, and how can they succeed in content design? Finally, there is the question of how to educate educators? (Bonk *et al., 2015*.) Professor Ruthmann (2014a) also expresses the following questions concerning music education: What kind of material is suitable yet not easy to get or perform on the web for web-based teaching? Sharing the same worries with

Bonk *et al.* (2015) Ruthmann (2014a) also asks how courses can be made that adhere the participants as peer-learners and mentors.

According to the research literature, the concept of informal learning and its place in the music education of both students and trainee teachers has become a prominent theme in recent times (Davis *et al.,* 2011; Feichas, 2010; Folkestad, 2006; Wright *et al.,* 2010) and informal learning has been researched in a case study by Ruismäki *et al*., (2012) showing how an enthusiastic adult amateur guitar player, Rane, used the Internet as a source of material and tools for learning. Mostly Rane searched for music and practice materials using Google and *You Tube*, but he also used an iPad and especially video podcasts available from iTunes. It seems that the iPad has given Rane a whole new environment in which to study music in Internet.

The benefits of the Internet as an open learning environment for instrument learning are, that students can practise whenever they wish, choose the most suitable online teacher and also the playing skill level. Unfortunately, there is huge amount of material on the Internet and it may also be of low quality, concerning both sound production and pedagogy. Consequently, it seems that intelligent search systems including user profile generators would be essential in further search-engine technology development in future (Levy *et al*., 2000; Micarelli, 2006; Yang *et al*., 2000) for supporting unsupervised music learning through the Internet. In addition to YouTube one can search for music education groups on Instagram, Tumblr and Google Plus. In addition there is Reddit, which has 114, 5 million visitors (Giebelhausen, 2015).

Although instrument learning courses are easy to load and use, in most cases there still remains the problem of feed-back: unsupervised learners cannot know if they practise in a right or wrong way, what their errors are and learn how to correct them. Researchers who are musicians themselves have aimed at creating systems in which the technical details of a player are evaluated from the recordings of the playing (Boo *et al*., 2006; Yin *et al*., 2005) and information concerning correcting the errors is given after the play performance. These systems are aimed at unsupervised home practising.

2.4.2 Research on adults as self-directed music learners

The instrument playing courses, *MOOCs,* found in the Internet are usually an amateur musician's method; they make it possible to learn on one's own schedule with low costs. The Internet has been found useful for adult amateur music students; part of them may have had some earlier studies during earlier years. Learning music and instrument playing without the control of a teacher makes the students active executors of their own learning process and utilizing resources and strategies is closely connected with the autonomy and self-directed learning skills of students (Song *et al*., 2007, Gazan, 2013); learners may have a

high level of self-direction in an area in which they are familiar or in areas that are similar to a prior experience. Informal learning is the norm for many adult learners and some researchers working in the area of self-directed learning have found that adult learners use resources from multiple sources to facilitate their learning goals without the involvement of formal educational institutions (Morrison *et al*., 2014; Merriam, 2001; Brookfield, 1984, 1993; Tough, 1967).

An area of particular interest for researchers has been the learners' ability to guide and direct their own learning; *self-directed learning* (Hartley *et al.,* 2001). According to an early description by Knowles (1975), self-directed learning is "a process in which individuals take the initiative with or without the help of others, in diagnosing their learning needs, formulating goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, 18). Researchers have also found that adults` involvement in music studies seems to improve their quality of life through providing opportunities to share, link life events and structure daily life (Hays *et al.,* 2005). In recent years, music making has had an important role in healthy ageing (see, Clift & Hancox, 2010; Cohen *et al.,* 2006; Hays, 2005; Laukka, 2007; Skingley, Clift *et al.,* 2011). Through music many older people found a means by which they were able to formulate their possible future selves, a sense of purpose and a strong sense of social affirmation (Creech *et al*., 2014) and learners themselves have indicated that they are "able to participate in the diagnosis of their learning needs and evaluation of learning experiences" (Merriam *et al*., 2008). Consequently, as self-directed learners, adults can be described as responsible for their decisions and choices through taking control of their goals and activities (Garrison, 1997) for life-long learning (Gibson, 2000).

Nevertheless, research has documented that the use of tools in computer-based learning environments is problematic in any age: learners either do not use the tools or they tend to use them sub-optimally (Collazo *et al*., 2014). Accordingly, researchers have found that instructional design (Song *et.al.* 2004; Dempsey *et al*., 2002), appropriate time management strategies and good enough technological experience and skills (Hooper *et al.,* 1995) are the primary factors identified as helpful for online learning. Because technical problems when using technology have long created challenges for music learners, hands-on workshops with the technology are needed to avoid unnecessary problems during the online courses. Data from research (Song *et al*, 2004) indicates that it is important that goals and/or objectives of the online courses are clearly stated so that learners will have a better understanding of what is expected of them.

Research is continuing to describe and analyse the complex interactions between people and computer-based technology (Sharples *et al.,* 2002) and there is a need to re-conceptualise the interaction between learning and the design of mobile technology (Taylor *et al*., 2006). The aim is to define human-centred,

socio-technical systems (people in interaction with personal technology) that are based on a sound understanding of how people think, learn, perceive, work and interact. (Taylor *et al*., 2005; Taylor 2010.) According to Chen (2015), there must be a dialectical relationship between the technological space, and the learning space. This is how to ensure that people have fully understood how to create pedagogically sound activities for mobile learners.

Although learning in a self-directed style is a rather lonely method, it has been found that the stronger the online learners' sense of online community is, the less isolated they feel (Rovai, 2002) and the better their own experience of learning is (Roulston *et al*., 2015). Teachers as well as students use weblogs, wikis, podcasts and social media platforms for discussions concerning their daily teaching and learning processes.

2.4.3 Home practice programs for unsupervised violin practising

Current advances in signal processing and interactive computing have enabled the development of sophisticated music learning aids and interactive computer games. Hämäläinen *et al.* (2004) introduced an educational method for singers in which the pitch of the user's voice was used for real-time control of computer game characters. In the computer games the "Voice as Sound" approach (Igarashi *et al*., 2001) was applied, which implies using non-verbal features in voice for direct control of interactive applications. The main idea was to use the pitch of singers' voices to control a game so that they could learn to use their voice correctly and sing in tune with the help of immediate graphical feedback from the visual objects in the game.

As a result of efforts to create systems that support learning violin technique without supervision of a teacher at home, a digital violin tutor program (DVT), has been developed by Yin *et al*. (2005). The student's playing is recorded, the data transcribed and compared to recording of the teacher's audio. In case of divergences or mistakes, the correct actions are demonstrated in animations (Jie *et al*., 2006; Yin *et al*., 2005). Another interactive CAMIT (Computer Assisted Music Instrument Tutoring) home practice system, the *interactive Digital Violin Tutor* (iDVT), was aimed at assisting beginning and amateur violin players in unsupervised violin practice. This method is based on keeping tracks of the player's performance, which makes it possible to check the playing after the whole performance. Because it is assumed that the players cannot concentrate simultaneously on two sounds – their instrument's sound, and the feedback information, (Ferguson, 2006), this arrangement enables the player to concentrate on the playing, while investigating the performance more carefully afterwards. With efficient and fully automatic audio-visual analysis components, the system can be easily deployed in a home environment (Zhang *et al*., 2009).

According to Huanhuan (2010) iDVT has three main benefits. Firstly, it provides informative feedback to beginners during unsupervised practice. Secondly, it is convenient for students in a home environment, by giving learners more flexibility over the time and place of practice. Thirdly, the hardware configuration of the system is low and cheap, which is affordable and cost-saving for the general public (Huanhuan, 2010). As Huanhuan notes, it will be important to seek cooperation with music institutions or schools in carrying out the further usability evaluation of the iDVT systems. It is also easy to agree with Percival (2008, 70-71): a system that generates targeted exercises must allow a human teacher to direct the whole flow and take considerate care of the student.

In conclusion, it seems likely that the recent learning environments should provide a blend of both face-to-face and computer-mediated components. Nevertheless: is it possible to follow the educational principles and methods that have been noted to work well in music education for hundreds of years and, at the same time take advantage of the new ones, which bring increasing access and flexibility of the resources and are cost- and time-saving learning strategies? For instance, can the recent refinement of telecommunication technology give educators and students a learning environment that is free from the restrictions of long distances between teachers and students? Children below the age of six are generally not capable of solitary or self-directed study on an instrument; accordingly mutual adaptation in the interaction between a student and a teacher is important. Also the role of parents is found to be crucial: when parents believe in the abilities of a young musician at the beginning and support them in close connection, the musician's own musical self-conception improve during the educational process and later it becomes a part of the musician's self-concept. In which way have the web based music teaching systems solved the problems concerning the missing of adult teacher or parent, who gives empathy and support in the learning situation?

2.5 Music education technology and distance learning of music

Finland has been a pioneer in the development of distance education systems via teleconferencing technology for a good reason: large distances separate the students from music schools in many parts of the country, especially in the Northern parts and it has been difficult to ensure availability of professional teaching for all students. By a happy coincidence there has been strong interest in developing music technology in the final years of the last century in Finland: musicians and technology experts began to research new methods for music education, music technology experimentation, scientific conferences, pilot projects and technology education for teachers were conducted (Juntunen *et al*., 2011; Juntunen, 2011). From the projects originated models and guides for technol-

ogy-based music education environments, such as a guide for music classroom arrangements (Unkari, 2012). Further, as a consequence of this elaboration, the distance piano teaching began in 2000 between Rovaniemi and Posio and in 2003 at the North-East College of Music. These projects were financially supported by The Finnish National Board of Education (Rantasuo 2006, 350-351). The distance learning classes were point-to-point or multipoint synchronous (real-time) distant teaching sessions between Helsinki, Oulu, Levi and Ylläs, Olos, Rovaniemi and Sodankylä in Finland. Later the distance learning projects were conducted from Finland to Israel, Sweden (Piteå), Greenland (Nook), South Korea (Seoul), Japan (Tokyo), Australia (Brisbane), Canada (Ottawa) and Norway (Tromsø). (Juntunen *et al*., 2011; Rajamäki, 2007.) Recently there has also been distance learning of instruments and the basics of music in the Music School of Kuhmo.

Sibelius Academy, like other universities, has an obligation to rural area development; accordingly, the commission of universities took part in the development project concerning music and youth education. In the rural area the development project explored the educational use of ICT, which advanced the skills of the education staff and created sustainable educational practices. Innovations and models were created for music pedagogical production and educational models were afforded for national education. The assignment report of Virtual University in Finland and the handbook *Music Education Technology* (Ojala *et al*., 2006) is based on the experience from the project.

Unfortunately Sibelius Academy decided not to continue the collaboration because no consistent policies based on the large developing work or systematic controlled research was formed (Ruippo, 2015: appendix 2, 10). The goals of the rural area development project were, however, mainly suitable for the participants of the project. Accordingly, for instance, *Virtuosi* (the organisation of Kuhmo chamber music) named web-based information mediating as one line of their operations, and the development of net-casting music services and the basement for music publishing were executed (Ruippo, 2015, appendix 2, 58). Although the Sibelius Academy (Kuopio department) was involved in the rural area development project, web-based teaching has only recently begun in education: mobile learning, video services and alternative learning environments are being used gradually (see Ruippo, 2015, 101: Tikkanen, R., personal report 17.12.2014; Väkevä, L., 2015, personal report 23.03.2015). Recently in the Sibelius Academy there is also educational activity such as shared courses with Tampere University of Applied Sciences, and master courses run by Päivyt Meller, following the model of the Manhattan School of Music. (Ruippo, 2015.)

Master courses via videoconference have recently been a part of Finnish University music education. In the University of Oulu web-based learning has been integrated to adult education (Ojala, J., personal report 17.12.2014). The same situation is in the music education of the University of Jyväskylä: the first

course subject concerned web-based learning material (Myllykoski, M., personal report 17.12.2014). Other institutes that deliver music teacher education include Oulu University of Applied Sciences took part in the Vi R music project (Vi R Music, 2010) from 2009 to 2011 and educated student teachers in distance learning methods and technology (Nissi, 2010). Tampere University of Applied Sciences affords pedagogy education for web-based teaching, including web-based learning material, web-based teaching in the basics of music and teaching students' own instruments via video conference (Ruippo, 2015, 90-102, 110).

According to Ruippo (2015, 106-107) there are some problems when using video conference in education: fire walls, the high prices of high quality devices, incompatibility of systems (for instance between Skype and H.323) and delays of transmission between two regions. Fortunately, this state of affairs will improve in the near future. Because modern computers have the capacity for using video conference data, using video conference through them will be possible nearly *real time* and the recent expensive video conference devices can be replaced with common computers. Even though one has to buy sound and video cards, a camera, microphone and speakers, the costs will be notably lower.

The most interesting line of progression, the video conference, is based on rapid transmission (more than 100Mbps). In this kind of system the transmission speed is so fast that video and sound need not be data compressed. The delays decrease significantly and practically playing together in separate regions is possible (Ruippo, 2015). These kinds of systems have been running during the last ten years: *LoLa* and Spanish *Isabel* (see Isabel Videoconference Software, 2015). Many performances have been arranged with *LoLa*; for instance, a clarinet quartet performance when two players were in Edinburgh and two players and the conductor were in London. The designer of the system, Gill Davies from the University of Napier (Edinburgh) listed the *pluses* and *minuses* like this: the good results in using *LoLa* in distance playing together are "saves time and expenses, opportunity to make music with new partners, possibility to take part in master courses, and the sound quality is good". The minuses are: "technical problems, placing video monitors and cameras may be problematic, the smallest musical details cannot be detected, acoustical differences between regions may be disturbing, visual feeling is two-dimensional, and inability to monitor sound in the other region (Ruippo, 2015, 107-108). Nevertheless, Ruippo considers that as soon as connection via optical fibre is in use after a few years, *LoLa* and similar applications will be available for everybody (Ruippo, 2015, 110).

The experience of a teacher's presence is worth discussing in connection with video mediated teaching (Holmberg, 2001). Concerning distance learning projects, Pinchas Zukerman, who has long given master courses in violin pointed out that, "You don't think about the computer when working; think about the human being" (see Donner, 2003), and echoing him Ruippo (2015) stated: "When using web-based music teaching, empathy needs to be emphasized".

Kangasluoma (2010) notes that the role of instrument teachers is crucial especially at the beginning of the pupils' studies. A teacher creates a safe relationship with the student and maintains a pleasant and enthusiastic atmosphere during the lessons and chooses challenging and interesting repertoires suitable for the level of ability and taste of the student. According to Lehmann *et al*. (2007), all early music instruction requires high levels of skilful adult support and interaction, because children below the age of six are generally not capable of solitary or self-directed study on an instrument. Vygotsky (1978) called the distance between what a child can do independently and what he or she can do with the help of a more skilled adult or peer the Zone of Proximal Development. In this interaction it is necessary that the teacher be responsive to the needs of the child and adapts the instruction level to the level of understanding of the child, but it also implies a *process* of mutual adaptation: the teacher gives instruction, the student reacts to that instruction, the teacher then reacts to the student's attempts, and so on (van Geert & Steenbeek, 2005).

The role of parents is also found to be crucial: when parents believe in the abilities of a young musician at the beginning, the musician's own musical self-conception improves during the educational process and later it becomes a part of the musician's self-concept. Thus a child's musical self-esteem, group participation and initiative are developed (Tuovila, 2003; Maijala 2003). According to Suzuki, musical talent is not determined by genes, but is shaped through the direct environment of the child (Suzuki, 1983). Similar to the ability of virtually all children to acquire their native language, musical skills can be developed in every child. In the Suzuki method, also known as Talent Education or the Mother Tongue Method, the emphasis is on memory training, learning through repetition and learning to play an instrument before learning to read notes.

Concerning the distance learning method, used more and more widely nowadays, there still are some issues to be considered. Is there a problem concerning the teacher's absence during the video mediated instrument lesson? Accordingly, how can the *face-to-face element* and the feeling of empathy and warm contact between a child student and the adult teacher be created in distance learning systems for children? Furthermore, which kind of learning communities can be connected with distance learning and why is the social network important especially when young children are concerned? Is there an especially crucial role for parents in the distance learning environment?

The next section describes an international violin teaching distance learning system in which most of the questions above are cleared in a natural way; the best worlds of face-to-face and technology supported teaching have been connected to make an efficient learning environment, involving gifted children, their local teachers, families and the expert master professor Geza Szilvay in a fine and motivating communion of music education culture for children and their families: the Minifiddlers.

2.5.1 Minifiddlers: an international distance-learning method for teaching violin to children

One of the most successful distance learning systems for young violin students, Minifiddlers, has been organized by a very popular violin pedagogue, Geza Szilvay, the developer of the Colourstrings method in violin teaching (Ruokonen *et al*., 2013). International Minifiddlers is a distance education project for violin studies developed by a Finnish violin pedagogue, Maarit Rajamäki (2007) and her company Caprice Ltd (see also Vi R Music, 2010). Maarit Rajamäki, founder of Caprice Ltd is a pioneer in creating high level music distance--learning environments in Finland. The company provides expertise and services on distance teaching and consultation on the technical execution of distance classes. The clientele includes music institutions, universities, teachers, musicians and broadcasting companies around the world. The Minifiddlers project cooperates with the Music and Brain Research Group of the University of Helsinki and the Department of Teacher Education (Ruokonen *et al*., 2013).

Violin professor Géza Szilvay teaches groups in Finland and around the world with the Colour Strings method that he created with Csaba Szilvay, his brother; the Colourstrings approach has gained an international reputation and is now taught all over the world. The countries involved in the Minifiddlers' international violin teaching distance -learning project include: Australia, Denmark, Faroe Islands, Finland, Germany, Greenland, Israel, Italy and South Korea; the number of participating countries continues to increase. Colour Strings institutions, schools, centres and societies have been established in several countries in order to realize and further this child-centred teaching concept (see Colour Strings, 2013). The Finnish students in Minifiddlers are from the East Helsinki Music Institute.

The distance-learning programme uses some of the latest teleconferencing technology for real-time instruction; furthermore, the sessions are documented for online broadcasting through MOOCs, where they can be studied unsupervised at home. Minifiddlers' learning environment is an excellent example of different kinds of learning environments described in Figure 3: supervised sessions mediated via videoconference technology, unsupervised MOOCs recorded from the distance lessons for home practising, a flipped classroom with online preparation for face-to-face lessons, blended learning in which online and face-to-face situations with local teachers take turns after each other, and also face-to-face learning with local teachers. Furthermore, participation in a common face-to-face group of Minifiddlers seems to be very meaningful for the children; some parents even seemed to prefer the group lessons compared to the traditional solo lessons.

Taking a wider view on learning environments, when developing effective learning methods to enhance giftedness and creativity in children, it is essential

to focus on both formal and informal aspects of learning and all the environmental catalysts that may connect to the intrinsic motivation in the learning environment (Ruokonen *et al*., 2013). Figure 4 describes how distance learning works with young, musically gifted children through their parents' experiences and the role of the main teacher, local teachers and parents in the violin playing education system.

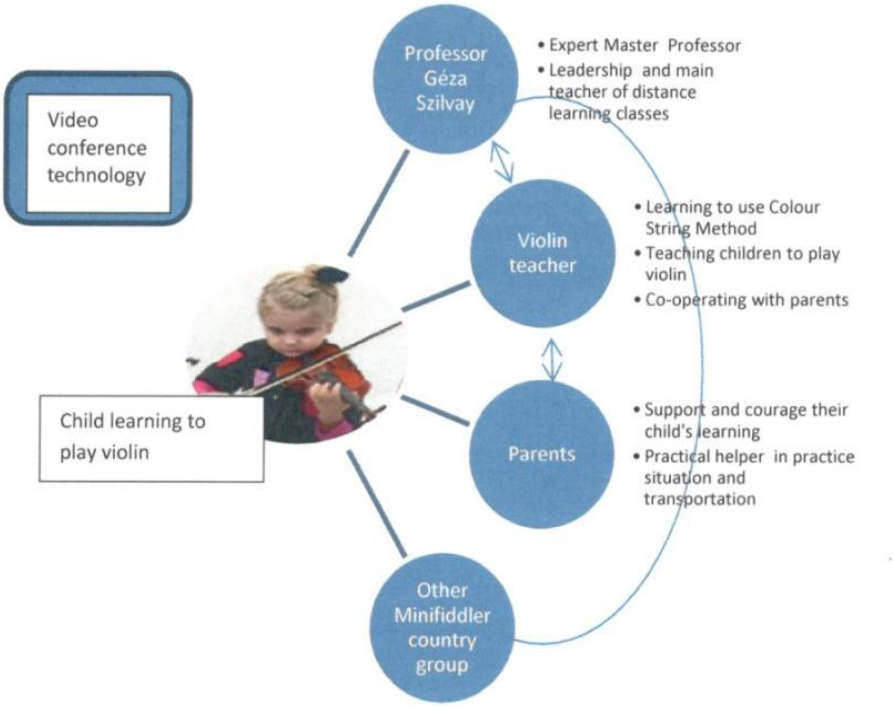

Figure 4. Roles of the participants in the Minifiddlers distance-learning environment

Figure 4 is adapted from a figured called "environmental sun" by Piirto (2002), which was aimed at supporting early giftedness. In this recent violin education system the children as very talented novice players receive professional expert teaching from professor Szilvay via videoconference as well as face-to-face instruction from their own local violin teacher. They also learn to practise daily with the support of their parents using the MOOCs, which are recorded lessons given by professor Szilvay. Accordingly, the distance learning environment in Minifiddlers includes many face-to-face contacts with adults to support the video-mediated teaching. In addition, professor Szilvay`s charisma and intimate presence are strongly transmitted on video.

When interviewing the parents (see Ruokonen *et al*., 2013), it was found that they realize their important role as supporters and helpers during practice and transportation. They listen to the lessons and value professor Szilvay's advice. In

addition, local violin teachers learn new methods and views when developing their pedagogy by learning to use the Colourstrings method with the professional support of professor Szilvay. Professor Szilvay also values active *learning by doing* principles [learning to play by playing] and he encourages the local teachers to motivate the children by giving them a positive feedback whenever possible. It seems that there is the experience of acceptance, support and encouragement as well as a good atmosphere and open joyful interaction in the whole Minifiddlers international distance learning group (Ruokonen *et al*., 2013).

In conclusion, although some earlier studies of distance learning reported overall effect results near zero, indicating that learning with these technologies, taken as a whole, was not significantly different from regular classroom learning in terms of effectiveness (Bernard *et al.,* 2004; Cavanaugh, 2004; Machtmes *et al.,* 2000; Zhao *et al.,* 2005), the Minifiddlers is an effective learning environment and its educational benefits are certainly worth wider research. Although teaching and learning occur partly outside the classroom, it still retains the most important features of face-to-face learning and its humaneness and feelings of togetherness.

2.6 Aural learning and practice strategies

Notation is a fine media for saving and learning music and learning it by reading the score. Nevertheless, to learn the sight-reading skills takes time and effort and in undesirable conditions may lead to anxiety and even turn students away from music studies and a life in music. Accordingly, to overcome the obstacles in learning new music pieces, some pedagogues support methods in which *listening* is emphasized more than *sight-reading* (reading from scores) as a basis for transmitting the musical information. Influential music educators, Kodaly and Orff proposed musical methods (Kodaly) and approaches (Orff) that were based on the idea of first experiencing and creating sounds, often using gestures, movement and games and then encountering notation at a later stage. In the Colourstrings method described above the sight-reading problem when teaching very young violin students has been solved by using a simplified version of notation appropriate for children who are only beginning to read: there are fewer lines, the notes are large and different colours indicate the particular strings.

In western instrumental education most instrumental teachers rely on a classical, notation-based method right from the first lessons (Chappell, 1999). Those conventional approaches tend to encourage children to learn small units of rhythm and pitch in the belief that these can be combined into longer sections of music. Yet some music researchers (see McPherson, 2002) point out that beginner instrumentalists find it very confusing to learn music in this "mosaic" way and suggest that a "too early emphasis on notation can lead to decreased aural sensitivity for the natural unified patterns that children spontaneously ob-

serve when listening to music" (McPherson, 2002, 105). Researchers have found that improvising and playing by ear have a close mutual connection (Gabrielsson, 2003). According to McPherson (2002), "Teachers should recognize the importance of ear playing as an important facet of training that enhances overall musical growth and provides for more enjoyable and meaningful learning". Accordingly, focusing on aural perception can facilitate also learning notation and sight-reading skills. These views and approaches continue to be popular today (Young, 2008).

Edwin Gordon (2003) and his followers have devised careful steps on how children can, through aural imitation and other practical activities, learn to audiate rhythmic, melodic and other patterns, and they even view such practice as mandatory before students begin to read notation. Gordon, as well as Houlahan *et al*. (2008, 143–162), who have been inspired by Kodály, refer to the maxim of "sound before symbol", strategies based on the students' skills of orientating in tonality. Cognitive research has suggested that musical enculturation, without specific training in music, is sufficient to lead people to an implicit awareness of tonality or tonal centricity in the music of their own culture. Nevertheless, there are views according which this awareness of tonality can be strengthened with musical training, so that listeners are able to recognise, for example, that melodic tones have different degrees of stability or 'fit' in a tonal context (Cohen 2000; Temperley, 2004; Thompson *et al.,* 2002, 466).

In fact, as evidence of the role of aural mechanisms in learning playing skills, researchers have noted that many instrumentalists appear to develop an ability to project pitch relationships to positions on their instruments, which thereby becomes a type of system for pitch relationships (Butler 1997; Covington 2005, 36). Further, according to research, the instrumentalists need anticipation, knowledge of which are going to be the next notes or passages, when reading a score from which they are playing (Hedges 1999, 42, 62–63). Consequently, the perception and anticipation of music in most situations needs larger and more flexible units than notes and rests to grasp meaningful units, called *patterning* (Serafine, 2013; Bamberger, 1994) or *chunking* (Karpinski, 2000, 73-77, 174).

Pedagogues have also been inspired by the recommendations on singing and silent score-reading stated by the composer Robert Schumann (Covington, 2005, 25; Paraczky, 2009, 87–88). Mental practising has also been found to be a typical strategy used by musicians when preparing for performances. One of the most useful outcomes is the ability to imagine the concert situation; this may raise one's self-confidence (Immonen, 2007). Accordingly, mental practising can help the musician to concentrate on the performance situation that most often causes nervousness and the lack of concentration (Morris *et al*., 2005, 223). When the individuals can imagine the performance situation in a positive way,

they begin to believe that they are capable of succeeding in a real situation (Weinberg *et al.,* 2014). As in many human situations, confidence is everything.

The objects of mental training can be technical issues, movements and automation (Immonen, 2007). Mental practice seems to be more effective than physical actions; it develops better rhythm, phrasing and dynamic skills (Rosenthal, 1988, 250–25.); even novices learn faster by mental training (Rideout, 1992, 474). An interesting finding is that the internal mental images when practising seem to be related to the kinaesthetic knowledge of the individual, as a kind of "knowledge of movement" (Murphy *et al.*, 2002). The "inner hearing", capacity to imagine in one's mind the music even though it is not possible for the musician to hear it, the mind`s ability to perceive, to remember, to compare and connect the tonal and rhythmic shapes music concretely, has been thought to be important (Elliott, 1995, 227-228).

Discussing further the movements and automation when learning to play, researchers note that the crucial aspect is not only the improvement in the physical or technical skills, but also the ability to control them mentally is important. Mental practising may lead to automatic performance which presumes the relatively low level of conscious control (Immonen *et al*., 2012). Playing "without thinking" means that the conscious active memory is not essential for such a performance (Sweller *et al.,* 1994; Sweller *et al.*, 1998). Further, when using mental training to increase self-esteem, the best way for musicians to improve could be to imagine the correct performance, not the "dangerous" errors that may occur.

Because sight-reading has a crucial role in institutional music education, a great amount of research has concentrated on this learning style (e.g. Elliott, C.A., 1982; Fourie, 2004; Galyen, 2005; Gromko, 2004; Junda, 1994;Kopiez *et al.,* 2006, 2008; Mc Pherson, 1994; Penttinen *et al.,* 2013; Pike *et al.,* 2010; Sloboda, 1974; Thompson, 1987; Truitt *et al*., 1997; Waters *et al*., 1998; Wristen, 2005). However, conventional notation symbols require beginners to spend a significant amount of time memorizing, which may discourage learning at an early stage (Kuo *et al*., 2013) and alternative methods are worth considering.

There is research that shows that audition-based learning is connected with musically gifted learners: when learning to play a new melody, less capable players tried to learn through figuring the note names but more capable players said that they were "singing in my head while fingering the piece on my instrument" (McPherson *et al.,* 2002, 108-109). As evidence of the deficiency of concentration in musicians leaning exclusively on sight-reading Woody *et al.* (2010) noticed that the non-formal musicians required fewer trials to perform a given melody than formal musicians, in significant numbers (Woody *et al.,* 2010). Musicians from different backgrounds such as folk, jazz and popular music are usually able to play without notation. In these styles music is either played without notation or from partially sketched music with minimal informa-

tion needed for a musician to play the song. An interesting study in the future would be on sight-reading from iPad`s AvidScorch in which the pointer shows where the music goes and the audio demonstrates the sounds.

Ear playing might be an important or even foundational skill that deserves more attention in research, music pedagogy and the school curriculum. In Hallam's words: "Knowledge of appropriate strategies is not useful in increasing the effectiveness of practice unless appropriate aural schemata have been developed to enable the monitoring of errors" (Hallam, 2001, 20). The music is checked and compared with music imagination, known as audiation (Gordon, 2001), which is a means for recognizing melody and rhythm, a human capacity outside the realm of words (Kuo *et al.,* 2013). As Burwell (2013) states, it is the teacher's responsibility to ensure that such an internal aural model will be acquired.

An interesting brain study concerning practising processes was made by Seppänen *et al.* (2007); they studied whether there were differences in auditory processing between musicians who preferred or did not prefer aural strategies such as improvising, playing by ear and rehearsing by listening to records. According to their results, the auditory processing of musicians who prefer aural practice strategies differs especially in melodic contour and interval processing, but also in perceptual learning in comparison to musicians preferring other practice strategies (Seppänen *et al.*, 2007). In addition, Hayward *et al*., (2009) found evidence that auditory skills are also fundamental for the mastery of sight-reading and aural-spatial imaginary is essential for playing from notation; furthermore these abilities have a positive effect on playing from memory (McPherson 2002, 109). It would be interesting to study how audio support in learning music is reflected in the brain.

From the pedagogical point of view (Lilliestam, 1996; Ketovuori, 2015), focusing too much on notation may leave children with too few resources for handling their instruments and listening to their own playing; this can prevent the students' ability to play more spontaneously, intuitively and by ear (Ketovuori, 2015). If the pedagogical goal is to train skilful all-round musicians that are capable of interpreting both classical and other styles of music according to their contexts, intuitive playing has to have more room in institutional instrument lessons than is currently the case (Ketovuori, 2015).

Accordingly, learning music with more direct routes than exclusively through sight-reading, with procedures using and developing inner hearing and auditive imagining of the music could be a good alternative choice. Concerning this view, the idea of using audio backgrounds to get an image of the music has long been used. Tapes and CDs to play the background "minus one", in which the part to be practised is muted or played with an instrument which is suitable for the learner (see *Music Minus One*). Nowadays, many kinds of tools for the back-

ground support, such as *YouTube*, *iTunes* and *Spotify* are available on the Internet for listening to the recordings of the music to be learned.

2.7 Learning and musical activities with mobile devices

With recent developments in portable devices like smart phones and tablets, it is possible to study physically outside the classroom wherever and whenever one wishes. In Siegle's view (2013), four key features account for the popularity of mobile devices: firstly, they are economically priced compared with laptops; secondly, there are low-cost applications; thirdly, young people are instinctively drawn to the intuitive touch design of pads and finally, pads are light and portable (Siegle, 2013). The Apple iPad with its applications, is the most popular of the tablets (Siegle, 2013). It is a very useful device in music learning because there are a large variety of applications for teaching rhythms, notation and reading music, accompaniment and karaoke. Recently, there have been about 300,000 applications available for the iPad; several thousand of them are music related (Ruismäki *et al.,* 2013).

One application available on the iPad is a violin-like instrument, the *Magic Fiddle*. It combines the physical, (gesture and artefact) and the virtual (graphical interfaces and digital audio synthesis) elements to an instrument which makes music performance more fun and accessible to the general public, especially for people who do not necessarily consider themselves as "musicians" (Wang *et al.,* 2011). The goal of the design was to generate a feeling of violin playing, a flow experience in which players are fully immersed in the playing and performance without long-lasting studies on the instrument. The strong motivation to improve with practising is supported by game-like and pedagogical elements and evaluation: at the end of each performance, the performer is shown the accuracy with the corresponding score and the global statistics show the users with the highest scores. The users themselves can see where they stand in relation to the top scorers.

Making an instrument have the properties of a violin by using a flat and rectangular object like an iPad has certainly been a challenge. According to Wang *et al*. (2011), to make the most out of the device's screen space, and as an aesthetic preference, only the parts of a violin which are essential for controlling a violin-like sound, the strings and a bowing region, were modelled and modified to suit the iPad. Because strings are more difficult to reach if they lie farther away from the edge of the screen, the final design has only three strings instead of four as the violin has. On a violin, the bowing angle determines which string is being played, but on a flat screen device in the iPad, it is not possible to bow at a different angle. This obstacle was solved by having a single bow region, and a touch point gesture on this general region would trigger all "active" strings. Further, to reward users who hold the iPad in the "proper" way (like holding the

violin), the bottom left corner of the iPad screen was reserved for the "chin rest". The score to be played was shown as an animated series of incoming notes to guide performers when and where to touch the string and the colour of the line segments guide which of the three strings should be fingered (Wang *et al*., 2011).

Initially, professional musicians who had tried *Magic Fiddle* complained about the lack of tactile feedback on individual strings and the lateral curvature of the traditional instrument's neck. Nevertheless, the ability to bow indefinitely (like moving around, an "everlasting legato") was appreciated. Regardless of the many differences, these professional musicians picked up the instrument almost immediately and have performed music as a "string quartet". In the three months following its release, *Magic Fiddle* had been downloaded onto more than 100,000 devices (Wang *et al*., 2011). Nevertheless, recently the *Magic Fiddle* is no longer available.

Mobile phones are becoming more important as meta-instruments. Although, unlike laptops, there is very limited sound synthesis software available for mobile phones, the typical power of the speakers of these devices does allow for a chamber music quality in quiet spaces while preserving the intimate instrumental qualities of these devices (Wang *et al*., 2008 b). Recently, mobile phones have been hyper-ubiquitous and deeply entrenched in the lifestyles of people around the world; they transcend nearly every cultural and economic barrier, which make them feasible for holding jam sessions, rehearsals and even performances almost anywhere, any time.

The emergence of the iPhone has catalysed mobile phones as a mature programmable multimedia platform. The iPhone thoroughly popularized the 'app' as a fundamental building block, with each app transforming the hardware mobile device into something new (e.g., a book, a camera, a game, a musical instrument). It also opened the doors for developers to easily create applications and distribute them to the masses through various 'app stores'. For music, this opened the doors for start-ups such as *RjDj,* which developed a new genre of music that it called *reactive music*; this is music that is able to react to the listener and his or her environment in real-time (*RjDj,* 2009). *ZooZBeat* (Weinberg *et al.,* 2009) and Smule's *Ocarina* (Wang*,* 2009) have opened up mobile performance to a broad audience and allowed it to explore expressive mobile music, as well as social musical interactions through mobile devices. *Ocarina* transforms the iPhone into a physical flute-like wind instrument with multi-touch, microphone, and accelerometer control of real-time sound synthesis; it has gained a user base exceeding ten million in size. *Ocarina* was one of the earliest mobile-musical and social-musical apps. It presented as a breath-controlled, flute-like instrument that was designed for the iPhone. *Ocarina* is also designed to be a social musical experience, providing a global visualization that allows users to listen each other's playing around the world. A social component of

Ocarina allows its users to hear one another around the world while displaying their GPS locations, enabling a type of semi-anonymous, geographically diverse music-making (Wang *et al.,* 2015). Mobile music-making apps necessitated ongoing investigations into data systems and representation for expressive mobile music (Hamilton *et al.,* 2011).

The idea of playing together with mobile phones was born from the laptop orchestra (Trueman, 2007; Smallwood *et al*., 2008; Wang *et al*., 2008a; Fiebrink *et al*., 2007). Golan Levin's *Dialtones* performance (Levin, 2001) is one of the earliest concert concepts that used mobile devices as part of the performance. According to Wang *et al*. (2010), the technology was stable enough to start forming well-defined ensemble and also create a persistent repertoire. Accordingly, *Mobile Phone Orchestra* was founded in 2007 at Stanford University's Center for Computer Research in Music and Acoustics and performed its debut in January 2008. Since then it has spawned new ensembles for instance in Berlin and Helsinki. The original *Mobile Phone Orchestra* consisted of sixteen players with mobile phones (Apple iPhones, iPod Touch, or Nokia N95) and contained a repertoire of publicly premiered pieces ranging from scored compositions and sonic sculptures to structured and free improvisations. So far, all works have used a combination of the phones' on-board speakers, custom-made glove-, wrist-, neck-, head- or waist-band speakers for sound production, combining a certain sonic intimacy found in traditional chamber music ensembles with the potential of new forms of electronic expression—a "mobile electronic chamber music" (Wang, 2014).

The *Mobile Phone Orchestra* is a repertoire-based ensemble that uses mobile phones as the primary musical instrument, employing more than a dozen players and mobile phones that serve as compositional, research, performance and educational platforms. Concerning group-based music activity, the members of the Mobile Phone Orchestra have explored music-making both in traditional ensemble settings as well as crowd-based settings (Kruge *et al.,* 2011; Oh *et al.,* 2011). In addition, Freeman and Godfrey (2010) crafted *Flock*, a multimedia work for saxophone quintet, dancers, video and an audience that participated in the production. *CODES* (Pimenta *et al*., 2011) synthesize social network and network music concepts in a cooperative music creation tool aimed at novice musicians. According to the concept of the performance, distributed location plays a conceptual role in a piece: a pre-composed piece is played by calling up various numbers of members of the audience. Visual projections display the spatial patterns that make currently sounding telephones "locative music" (Wang *et al*., 2008b).

A goal of the Mobile Phone Orchestra is to explore the possibilities of the fusion of technological artefact and human musicianship and provide an opportunity to explore what could be called "mobile electronic chamber music". Specifically, the availability of accelerometers in programmable mobile phones like

Nokia's N95 or Apple's iPhone has been an enabling technology to more fully consider mobile phones as meta-instruments for gesture-driven music performance. The first sound synthesis on mobile phones can be traced back to Geiger's *PDa* (Geiger, 2003), *Pocket Gamelan* (Schiemer *et al.,* 2006), in which performers physically swung drone-generating mobile phones on cables around their bodies and to *Mobile STK* (Essl *et al.,* 2006), which was a port of the *Synthesis Toolkit* (Cook *et al.,* 1999) to the *Symbian OS* mobile platform. Essl *et al.* (2007) explored the potential of mobile devices for music creation with *Shamus* and *Camus2*, both leveraging on-board sensors (e.g., camera and accelerometers) to create interactive mobile music instruments (Essl *et al.*, 2007; Rohs *et al.*, 2007). The notions of interactivity, music expression and physicality pervade their works (Essl *et al.*, 2009). An emerging community of mobile music was described in 2004 (Tanaka, 2004) and later in 2006 (Gaye *et al*., 2006) in the context of *New Instruments for Musical Expression* (NIME).

Recently, the combination of powerful mobile devices and the connective potential of cloud-based computing have changed how, where and when people use computers. While persistently connected to the network, computers embedded in mobile phones and tablets freely roam in daily life alongside their human users. This makes it possible to use models for musical interactions based on mobile devices designed to connect hundreds of thousands of users in a social-musical game involving expressive musical performance and collaborative musical feedback. In a case study around a commercial iPhone application, *Smule's Leaf Trombone: World Stage*, Wang *et al.* (2015) explored the crowdsourcing ecosystem that incorporates expressive music-making and game-like elements, aimed at inciting a mass audience; such musical experiences are not only 'mobile', but also were perhaps never possible before the new technology was used in mobiles. The *World Stage* is the first instance of applying ideas from crowdsourcing for the social interchange of musical performances and gathering feedback on those performances (Wang *et al*., 2015).

Smule's Leaf Trombone: World Stage was conceptualized and created to leverage the collective intelligence and judgment of the crowd to provide musical critique and feedback for user-generated performances. The work was inspired by the idea of *human computation*: new possibilities to use people to solve tasks that are traditionally hard for computers, but easy for humans: evaluating the human aspects of music like aesthetic, emotion, intent and expressiveness. For example, the notions around *Human Computation* (Law *et al*., 2011), *Game with Purpose* (Von Ahn & Dabbish, 2004), and cloud-based services like *Amazon Mechanical* (Turk *et al*., 2002) place humans into the problem-solving loop and position technology to take advantage of human intelligence, expertise and judgment. *World Stage* was motivated by the realization that it is difficult for computers to give 'deep' feedback on a musical performance, especially when it involves attributes such as expressiveness, virtuosity and musicality.

Smule's Leaf Trombone: World Stage provides a platform on which users can create musical content, perform using a mobile phone-based instrument, and present that performance to the greater community, a large community of users, whose creative human output is brought through technology. The musical interaction and physical interaction of Trombone were greatly influenced from experiences building musical instruments for the laptop in laptop orchestras since 2005 (Smallwood *et al.,* 2008; Trueman, 2007; Wang *et al*., 2009 a, b), and later the mobile phone orchestra since 2008 (Wang, 2014; Essl *et al*., 2010; Oh *et al*., 2010). This particular school of design emphasizes expressiveness and physical interaction design; it also embraces the unique capabilities and limitations of commodity computing devices and their various sensors.

Smule's Leaf Trombone: World Stage has its roots even farther back, beginning with early network computer music ensembles such as *The Hub* (Gresham-Lancaster, 1998), which explored the technology, methodology and aesthetics of performing with interconnected computers. Networked musical performance (Kapur *et al*., 2005) is an ongoing investigation into the technology and art of live music performed by participants at many locations around the world. More recent networked musical performances have explored 'locative media' (Tanaka *et al*., 2006), leveraging GPS and networking. Notable experiments and installations include Sonic City (Gaye *et al*., 2003), which casts the urban environment as a musical interface, Gps Tunes (Strachan *et al*., 2005), which uses audio feedback to control navigation, and Net Derive (Tanaka *et al.,* 2008), thought which information collected via embedded sensors in participants on the streets is sent and visualized in a central art installation. Additional experiments and systems include *Quintet.net* (Hajdu, 2005), *JackTrip* (Caceres *et al.,* 2010), back-end server and discovery mechanisms like *DIAMOUSES* (Alexandraki *et al.,* 2010), and compass-based social mobile music (Tanaka *et al*., 2007). Additionally, there have been a number of works exploring various aspects and interpretations of networked music. Kim-Boyle (2009) surveys a number of musical and aesthetic approaches to network music, including building instruments from the network itself, methods of audience feedback and social interaction of participants. Makelberge (2012) addresses issues of creative autonomy and the social interactions inherent in various technology-mediated music-making in wide-area network contexts, especially as related to sampling and mash-ups.

Smule's Leaf Trombone: World Stage has had over its lifetime an estimated base of more than 800,000 users on the iPhone and iPod Touch devices. The core of users is not musically trained. For many users, a World Stage rendition of Twinkle, Twinkle Little Star (the default song played in the app's tutorial) may be his or her first public musical performance. In this way, *World Stage* presents new musical opportunities to users who would have previously had few chances to express themselves musically. The *World Stage* app can be seen as a proof of the concept for a new type of ecosystem with multiple roles that feed

into one another. Composers (the smallest group) add content into the system; performers provide performances, the primary World Stage commodity; users serve as judges to give criticism and feedback to each other. Judging sessions are part of the World Stage 'public record' for any user. (Wang *et al*., 2015.)

The iPad is an excellent device for both traditional classroom-rehearsing and home practising users. The files written with the Sibelius notation programme can be sent via email to be opened by the music students in the *Avid Scorch* application and listened to or printed at home. In *Avid Scorch* scores, the tempo can be changed to any level by moving a switch; the part to be visible can also be chosen from full score to one individual instrument. All the "invisible" instruments can be heard simultaneously; if needed, one can adjust or mute the volumes of each instrument with the mixer. Furthermore, the score can easily be transposed to different keys.

Using the iPad as a tool in teaching music with technology is described in a case study (Ruismäki *et al.*, 2013) concerning one music teacher, Arto Joutsimäki, who describes his method. He used a notated score projected on the wall to be edited and played together in the classroom. According to him, the pupils find it easy to follow the score in front of them on the screen and there is no need to count the breaks as everyone can see from the score when and what their own group of instruments is supposed to play. It has been noticed that this method is rewarding for students also because they can listen to their own parts or play-together with the playback of the whole orchestra at home. Thus, they are well prepared for the next lesson. Joutsimäki informs in his article (Joutsimäki 2006, 304) that learning is fast with this method and that using playback when practising motivates both students and their parents. In home practising the pupils learn to play in the right tempo, after making a mistake here and there.

During nearly the same years as Joutsimäki worked, Juntunen also has used an educational design in which notation programme playback has been applied as an educational tool (see articles I-VI). In Juntunen's approach, the playback of a notation programme is used as an aid when practising orchestra scores. If the *Sibelius 6* or *7* notation programme has been used, an iPad has been the best device for sharing and playing the scores, but also recorded audios from *Sibelius* or *Encore* notation programmes and in some cases CD tracks have been used as an audio support for learning. The method has been called the *Playback Orchestra* method.

2.8 The *Playback Orchestra* method in learning violin and playing together

Computer programmes originally designed for composing and producing music are recently an important part of computer-assisted music instruction. As Ojala (2006) emphasizes, the use of music education technology does not replace living music playing and teaching with machinery; rather it enhances developing, researching and advancing new methods inside music teaching and learning and exploring how to use technology to support teaching. According to Myllykoski (2006), the programmes can roughly be divided into notation programmes, sequencer software, accompaniment applications, ear training programmes, audio editors and instrument learning software.

One example of using notation programmes as a tool for instrumental learning is the use of keyboard studios (Oksanen, 2003; Daniel, 2004; 2006), which are a learning environment for both independent and teacher-instructed learning. The central subjects in the studios are ear training and music theory, free accompaniment, including accompaniment styles and improvisation. Knowledge of chord signs, transposition and harmonisation with chord rotation are also featured in the curriculum (Tauriainen *et al*., 2012).

Nowadays the notation programmes are being used quite widely in music education. The playback is an effective aid for the writer to check that the notation is correct, but it can also be used as a tool when practising the music (see articles I-VI; Joutsimäki, 2006, 304). The players can listen to the playback to get the idea of the music and they can also play along with it. In pedagogical use this method is a perfect package: after having written the scores they can be sent via email to the students to be listened to, printed and played along at home from the computers, or, which is the usual case recently, from portable devices. The method is easy to use if one manages the basics of using notation programmes and the prints are clean and easy to read, unlike the manuscripts often are.

Stephens (2003) has noted that writing scores with music technology systems rather than manuscript paper the composer or arranger of music is working directly with sounds, not just symbolic representations of sounds (Stephens, 2003, 285-286). When writing scores with notation programmes *Encore 5*, and later *Sibelius 6* and *7* the author of this thesis soon found that the playback can also be used as a kind of orchestra simulator when practising new orchestra scores. The scores written with a notation programme can be edited easily and quickly to be suitable for using as an audio background for practising. The instrumentation can be chosen between the whole orchestra and one or two instruments and the balance between them can be changed. The scores written with notation programmes are digital files; accordingly, they can be sent and received via email. If the students have the same programme with which the score was written, they

can open and use scores at home on their computers. If they do not have the notation programme, the teachers can send an audio, for example, aMIDI file, from the score or the scores can also be burned to CDs to be listened on CD players. Nevertheless, the playback has an important advantage compared to any recorded media: the tempo can be changed by moving a switch. Accordingly, the students can practise the scores in tempos that fit their capacity: first slowly, then faster. Nowadays the *Playback Orchestra* method can be easily used in mobile devices, especially on *iPads*. If the scores sent by the teachers are written with the *Sibelius* programme, students can open the files in the *Avid Scorch* application on their iPads to be listened to and read, printed and played along at home. The *Avid Scorch* app, like most of the iPad applications, is very cheap; currently, it can be purchased for less than two euro. For students who already have an iPad, this is the entire cost for using the *Playback Orchestra* method at home.

Figure 5 describes the conceptual framework concerning the learning environment of the *Playback Orchestra* method. Three agents are introduced: Playback learning, Motivation and Musicianship skills. The focus is on learning musicianship skills by the audio-supported learning method with its flow-like learning strategy. Using the method increases motivation for practising, listening or other forms of music engagement. All the elements work together and build a rich learning environment for musicianship.

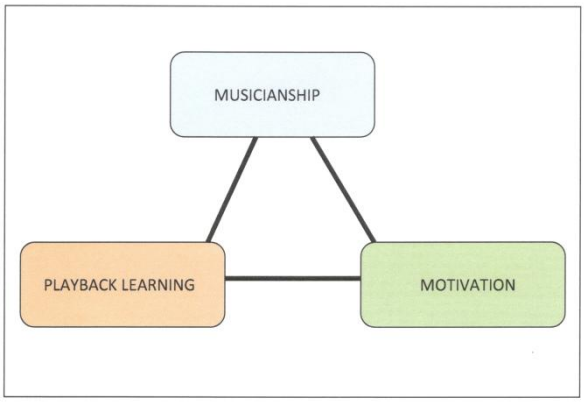

Figure 5. Conceptual framework of playback learning. (Adapted from Chen, 2015, Figure 1)

Learning musicianship skills takes years of persistent work; accordingly *motivation* is needed to run the music learning processes. In the words of Renwick *et al*. (2012), "showing high and enduring level of interest, to seek and find pleasure in optimal challenges" (Renwick *et al*., 2012).

At the beginning, the playback element was used exclusively during the lessons, but later, especially when the use of iPads expanded to families and stu-

dents, the method has been used through the *Avid Scorch* application in home practising. After players have used the *Playback Orchestra* method from the beginning of this century, according to the comments of the students and families, and my experience, as well, motivation for practicing has increased. Accordingly, the repertoires of the orchestras have grown much larger. Because the orchestra players know their scores beforehand, the rehearsal can be used for deepening the style of playing and orchestra-like working procedures. Further, the author of this presentation has found that the atmosphere when playing in rehearsals and concerts is relaxed and joyful. The students are self-confident when they know the music thoroughly, both their own scores and the full score. Based on these positive experiences when using the *Playback Orchestra* method, research on its effectiveness and educational properties was conducted to determine if the method could be suggested to complement the traditional face-to-face play-together teaching tools and methods in music schools.

3 Structure of the research

The aims of this research are: to introduce a new practice method, the *Playback Orchestra* method in which the students practise their play-together parts with the support of an audio of the full score, to test the method with pre- and post-study design and to introduce a learning environment that combines traditional face-to-face classroom teaching with a computer-assisted home practice component. The *Aims and research questions* and *Study design* sections describe the outlines concerning the study on the impact of the *Playback Orchestra* method.

3.1 Aims and research questions

The new technology-based component, the *Playback Orchestra* method, has been tested to find answers to two basic questions. First*: "How does using playback as a support profit learning to play skills, which particular skills are helped and in which way?"* In this research the basic playing skills are expressed as skill groups, which include several separate skills in the same category. For example, when the evaluators were asked four different questions about *right-hand technique*, these four questions are considered to be four separate right-hand skills (expressed as separate variables) and the sum variable *right-hand technique* has been calculated from them.

The second research question concerns musical improvisation: *"How does learning a musical tale with audio background support learning improvisation and which improvisation skills are especially helped?"* After exploring a wide range of research, no generally agreed view concerning a good musical improvisation performance was found (e.g., Peck 2013; Elliott 1995; Kertz-Welzel, 2004; French, 2005; Burnard, 1999, 2007). Accordingly, most of the questions concerning improvisation skills were chosen intuitively aiming at describing the improvisation performances based on impression rather than reason or fact. Some questions mirror earlier research, especially the research results of Burnard (1999), who noted that the players aim at intentionally directed maintenance of continuity during improvisation (Burnard, 1999). A few questions originated from earlier research results concerning the effectiveness of the *Playback Orchestra* method reported in articles I-IV.

In addition to creating a new larger learning environment by adding a technology-based practice method to traditional methods, new material for orchestra and play-together education was created. This material consists of orchestra etudes aimed at students who are practising various rhythmic patterns, using the bow in a coherent style in orchestra, using intonation based on combining the

violoncello and violin parts to support each other on a harmonic basis. The new material can be found on *Score Exchange* web sites.

3.2 Study design

The research problems in this thesis were chosen to be in harmony with *Bases for evaluation in violin basic education* (The Association of Finnish Music Schools, 2005) and based on the comments of a viola and violoncello teacher when asked to characterize the music and special playing skills needed in playing a particular piece of music (see Appendix 8-10). Following the general practice when evaluating the students' playing performances in music schools, the performance as a whole was evaluated first. The *Performance as a whole* signifies the impression of the playing in a quite large view and was not defined exactly for the estimators. The *Style, Overall picture* and *atmosphere,* likewise, was supposed to be estimated with intuitive criteria based on the estimators' experience as teachers and musicians. *Overall picture* (mentioned in articles III-V as 'the big picture' or overall/general view) , signifies the players' skill to construct a relevant structure of the music and play it "out" by using the dynamics, agogicks or phrasing styles. The *Style* and *atmosphere* can also be expressed by the player with many, or rather, all the means available in expressing the contents of the music by playing an instrument. The skills *Dynamics* and *Phrasing* are more precise in content: playing with clear and appropriate dynamic changes and phrasing the music clearly and naturally. The questions concerning *Left-* and *Right-hand technique* refer to the *Bases for evaluation in violin basic education* (The Association of Finnish Music Schools, 2005) in quite a straightforward way and *Playing together* in this study means the players' skill in following the leader if the score is an accompanying part (article IV), or when the score to be learned is a leader's score (article III), the skill to lead the group by playing. Table 1 describes the study design: research problems, data collection and analysis and the articles concerning the issues.

Table 1. An overview table of the study. Research questions, data collection, data analysis and corresponding article(s)

Research problem	**Data collection**	**Data analysis**	**Arti-cle(s)**
How does playback support learning play-ing skills?			
The performance as a whole	Pre- and post-learning testing	Quantitative	III, IV, V
Style, overall picture and atmosphere	Pre- and post-learning testing	Quantitative	III, IV, V
Dynamics and phrasing	Pre-and post-learning testing	Quantitative	III, IV, V
Left-hand technique	Pre- and post-learning testing	Quantitative	III, IV, V
Right-hand technique	Pre- and post-learning testing	Quantitative	III, IV, V
Reading the score	Pre- and post-learning testing	Quantitative	III, IV, V
Playing together	Pre- and post-learning testing	Quantitative	III, IV
How does learning a musical tale with audio background support learning improvisa-tion?			
Decisive beginning	Pre- and post-testing, describing situations	Mixed: quantitative and qualita-tive analysis	VI
Intense continuity	Pre- and post-testing, describing situations	Mixed: quantitative and qualita-tive analysis	VI
Flow, atmosphere	Pre- and post-testing, describing situations	Mixed: quantitative and qualita-tive analysis	VI
Concentration	Pre- and post-learning testing, interviewing, describing situations	Mixed: quantitative and qualita-tive analysis	VI

Independence	Pre- and post-testing, describing situations	Mixed: quantitative and qualitative analysis	VI
Originality, (own ideas)	Pre- and post-testing, describing situations	Mixed: quantitative and qualitative analysis	VI
Relaxed movements	Pre- and post-testing, describing situations	Mixed: quantitative and qualitative analysis	VI
Joy of playing	Pre- and post-testing, describing situations	Mixed: quantitative and qualitative analysis	VI
Overall picture of the improvisation passage	Pre- and post-testing, describing situations	Mixed: quantitative and qualitative analysis	VI

To find answers to the research problems, a quasi-experimental study design was used. The test group (later called the *playback group*) practised their scores with the support of an audio background and the control group (the *no-playback group)* without it. Both study groups read the music from printed scores. Two professional violin teachers evaluated the playing from video before (PRE) and after (POST) the four to five weeks practice period. The testing of each piece of music was run once a week and all test situations were video recorded. The POST testing was either a live situation in which both study groups played along with live piano accompaniment (*Andante*), or a "quasi" live situation in which both study groups played along with a recording of a live piano accompaniment (Bauernkantate), recording of orchestra rehearsal (Mickey Mouse and Improvisation), or a Play Along CD (*You Only Live Twice*). The estimators evaluated play performances from video by scoring 2, 2+, 3-, 3, 3+, 4-, 4, 4+, 5-, and 5. This scoring style was chosen because it resembles the evaluation procedure used in the music school in which the two estimators teach. The scorings were coded again to 1-10 for the statistical analysis. The learning results were analysed with SPSS 22 and general linear and mixed linear models.

The design of the study is complex: measures of "before" and "after" the practice period; two estimators, and repetition of estimators and tested students. Thus, to carry out statistical tests we needed a model that could be used for repeated data involving a categorical and continuous covariate. Accordingly, because we cannot assume independence of the data in this study, a linear mixed model (LMM) was chosen as an appropriate method (Galwey, 2006). LMM is regression analysis, which takes into consideration the dependence of repeated measures, it was used with Bonferroni correction. Bonferroni corrections are

employed to reduce Type I errors (i.e., rejecting Ho when Ho is true) when multiple tests or comparisons are conducted (Nakagava, 2004).

For statistical analysis of data, the "best" model should be selected, i.e., a model that is parsimonious in terms of the parameters used and at the same time is best at predicting (or explaining variation in) the dependent variable. In selecting the best model for a given data set, we take into account research objectives; sampling and study design, previous knowledge about important predictors, and important subject matter considerations (see West *et al*., 2014). In linear mixed model (LMM) we estimate the fixed-effect parameters (see Casella *et al*., 2002). For this recent research the model used for statistical analysis is a linear mixed model, because it has many advantages over software procedures with traditional repeated-measures ANOVA models: LMM software procedures, for instance, allow subjects to have missing time points, whereas software for traditional repeated measures ANOVA models drops an entire subject from the analysis if the subject has missing data for a single point (known as *complete-case-analysis*, see Little *et al*., 2014).

Applications of mixed models are common in the social sciences, especially in research concerning education. The development of software for fitting linear mixed models has advanced in statistical methodology power in the late twentieth century. Several existing texts provide theoretical treatment of linear mixed models and the analysis of variance components (e.g., McCulloch *et al.,* 2001; Searle *et al*., 1992*;* Searle, 2001*;* Verbege *et al*., 2000*).* The specific syntax and available options are changing as newer versions of the software are released. The most up-to-date versions of selected portions of the syntax are available on this website: http://www.umich.edu/-bwest/almussp.html

The issues and results of testing playing skills are dealt in articles III-V. The playing together was not estimated in article V, because the audio used in the POST situation was a CD track (see Table 1.) The improvisation research was a qualitative case study combined with quasi-experimental tests and quantitative analyses. A case study can be chosen as a method when a researcher wants to understand a phenomenon deeply and explore its context widely (see Kvale & Brinkmann, 2009: Yin, 2013; 2014; Roulston, 2010). The data was collected from pre-post scorings as in the previous studies; from observing and describing improvising situations from the videos recorded during the testing and individual features of players from knowing the students after many years of teaching them. Figuring that evaluating improvisation by numbers is not "natural" for music teachers as estimators, their evaluations were carried out by the VAS scale. It was thought to be a more "descriptive" measuring tool than numerical symbols.

Many scholars agree on the statement that using mixed methods offers a possibility to access a versatile and profound understanding of the subject (Teddlie *et al.,* 2009; Brannen, 1992; Creswell *et al.,* 2007). Explaining the richness and complexity of human behaviour by studying it from more than one standpoint

and making use of both quantitative and qualitative data is found to be a good approach in social sciences (Cohen *et al.,* 2007 b, 141). According to researchers, mixed methods also add to the validity of the research, as the same results are gained using different approaches (Anttila, 2005).

The participants in the testing were from the Music Institute of the Western County of Southern Finland, Vihti. Ten of them were first-grade and four were second-grade string instrument students. The participants for study groups were chosen randomly. To evaluate the homogeneity in the study groups concerning playing skills, the participants were pre-tested at the beginning of the testing period. For the pre-testing all the students of the first-grade group practised a shared piece of music and the second-grade group players learned a more difficult shared score. To get more information of the playing skills of the participants, evaluations were conducted of their concert performances as an annual examination two months before the testing by two violin teachers; one evaluated them in a live concert situation and the other teacher assessed a video. The player information of all participants is presented in Appendices 6 and 7.

Four scores were chosen for testing for both first- and second-grade participants: a main melody, an accompanying score, an accompanying score in a long composition with many different passages and an accompanying score in special playing style. On the basis of approximate inspection of the data from the testing, two of the main melody scores, *Andante* by E. Elgar and a film melody from James Bond, *You Only Live Twice* by J. Barry and one accompanying score, an excerpt of *Bauernkantate* by J.S Bach was chosen for closer analysis, because they seemed to include clear differences in the data between the study groups. The *improvisation* passage from a long musical tale *Mickey Mouse in a Storm* was later also chosen to be analysed.

At the beginning of the first test situation, both study groups listened to the playback of the test score, then they were given a printed score of the music, questions concerning the key and time signature, tempo and expression markings were determined and the scales in the relevant keys were played. Thereafter, the teacher who was running the testing (the author of this dissertation) played the score together with every student; the *playback group* played with the support of a notation programme playback system and the other group without the playback. After that the *playback group* played the printed score with the support of playback and the *no-playback group* without playback. The playing was video recorded as a PRE (before practice period) test performance for the two estimators to be evaluated.

The *playback group* was given a CD which was burned from the playback of the score in different tempos. Concerning the film music (article V) a play along CD including orchestra background without the violin part was used for home practising. The video recorded testing situations were repeated three times, one testing per week, but the preparatory stages with questions and scale playing

were not included in them. After the practice period the POST (after practice) the testing situations were video recorded for evaluation.

4 Results

The analysis of the data concerning learning new scores and improvisation with or without audio support is described in the results section of this thesis. Next general conclusions about the results will be discussed. Based on this recent research and examined research literature, a metaphorical model, a *gearwheel model*, is introduced to describe the interactive roles of *understanding* the music on the basis of *hearing* and the influence of understanding on *playing* style and *memory*. After discussing research on auditory imagery, which is supposed to be engaged in aural learning style and also after considering the flow-like learning strategy of the *Playback Orchestra* method, the new learning environment, *blended learning* in music school instrumental instruction, is introduced. It is a combination of traditional face-to-face teaching and a technology-based element, the *Playback Orchestra* method. In the learning environment described in this study the major part of education is supervised face-to-face teaching in classroom in which using traditional methods takes 82% and using *Playback Orchestra* method during instrument and play-together lessons consumes 13% of the student's time; unsupervised learning with the *Playback Orchestra* method at home takes only 5% (see Figure 19). The percentages are rough approximations, but they do convey a general picture of the learning environment in which *Playback Orchestra* method has been used.

4.1 Playback support in learning playing skills

To determine how effective the *Playback Orchestra* method is, it was tested with a quasi-experimental study design in which two professional violin teachers evaluated the playing before and after a practice period. One group practised a test score with the support of an audio of the whole music piece (the *playback group*) and the other study group without the audio (the *no-playback group*). The results of the testing are described below (and in articles III, IV and V, improvisation in article VI), as well as preliminary considerations and larger views opened by the partly high significances of differences between the study groups in favour of the *playback group*.

When considering the results from testing the *Playback Orchestra* method, it was found reasonable to discuss each piece of music used in the study separately, because the questions asked of the evaluators were specific to the particular piece of music. In the results are shown both the results concerning separate variables (which are separate playing skills) and sum variables, which are con-

structed from two to four separate variables that all indicate the same group of skills.

4.1.1 Edward Elgar's *Andante*: The leader`s score

Edward Elgar's *Andante* was a very natural choice to be the first piece of music in testing to be played by the first degree string instrument players and evaluated by the estimators: teachers are experienced in the examinations of music schools in giving scores for the students when they play melody parts of compositions. Elgar's piece of music is a short expressive melody, a first violin, or leader's part in a chamber music composition. The melody has a very clear structure: a melody line that is supported with the harmony, and dynamics in the audio of the full score. The violoncello and viola players had the same melody as violin players with an octave change in bars 7-12 (Appendix 1 and 2).

The *playback group* (test group) practised the melody with the support of a notation programme playback and the *no-playback* group (control group) without it. Both groups read the printed score during all the test situations; after the practice period, all players performed Elgar's *Andante* in a live situation with a piano teacher. All test situations were video recorded and two violin teachers evaluated the first (PRE) and last (POST) performances via video.

According to the results, the performances were better in the *no- playback* group at the start, but the *playback group* learned faster during the practice period (Juntunen *et al.*, 2013, article III).

Figure 6 .Overall changes in study groups from before practice to after practice in Elgar testing. Means of all variables and the two estimators of the performance

The finding that the *no-playback* group was higher at the start might result from differences in the learning strategy when practising with or without the audio: the ongoing music in the audio background makes the player continue playing and not stop when playing wrong. However, during the repeated play situations, the flow-like learning strategy of the *playback group* generates faster improvement than the traditional learning style of the *no-playback* group (Figure 6).

As an overall result it was found that the playback support was very effective: all skill groups improved faster in the *playback group* than in the *no-playback* group (Figure 7).

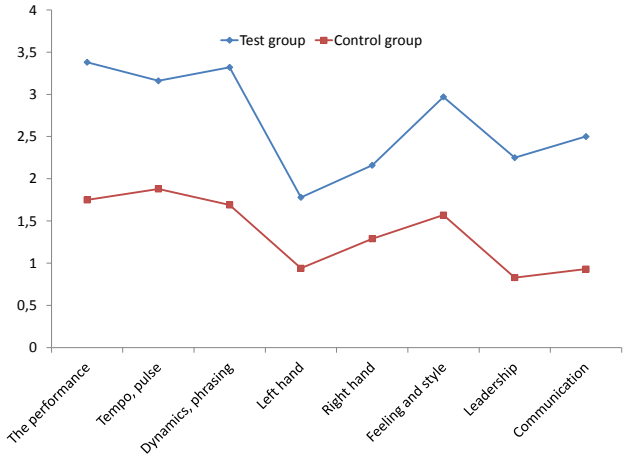

Figure 7. Improvement of study groups in Elgar testing. Sum variables, means of separate variables and the estimators

The sum variables were calculated from four separate variables (skills) connected with the same kind of playing skills. The choice of sum variables was based on the *bases for evaluation in violin basic education* set by the Association of Finnish Music Schools. According to statistical analysis of the results of the sum variables, the *dynamics and phrasing* (p= .027) and finding the *feeling and style* (p=.023) improved faster in the *playback group* than in *the no-playback* group in statistically significant numbers (Table 2).

The last sum variable in Table 2 was calculated from all separate variables connected with communicating the contents of music by playing to the group as a leader player. The sum variable *communication,* which indicates sharing information concerning the style of playing and leading the group by playing, improved faster with playback supported practising than without it in highly significant numbers (p=.003, see Table 2).

Table 2. The differences between study groups in learning Elgar's *Andante*. Means of separate variables and the estimators. Significances by mixed linear model

Sum variable	**Difference** between methods in favour of playback method	**Significance** of differences Mixed linear model
Tempo and pulse	1,28	p=.136
Dynamics and phrasing	1,63	p=.027
Left hand	0,84	p=.111
Right hand	0,87	p=.114
Feeling and style	1,43	p=.023
Leadership	1,42	p=.124
Communication (Sum variable computed from separate variables v3,v5,v7,v8,v11, v21)	1,57	p=.003

Concerning the separate variables in the Elgar study, all skills in the *playback group* improved faster except, *position and relaxation of the left hand* (v13, see Figure 8). The difference in favour of the playback group was largest in *communicate large dynamic changes* (v11), *find and communicate the general structure of the music* (v7), *find and express dynamic marks* (v9) and *use tonally based intonation* (v15).

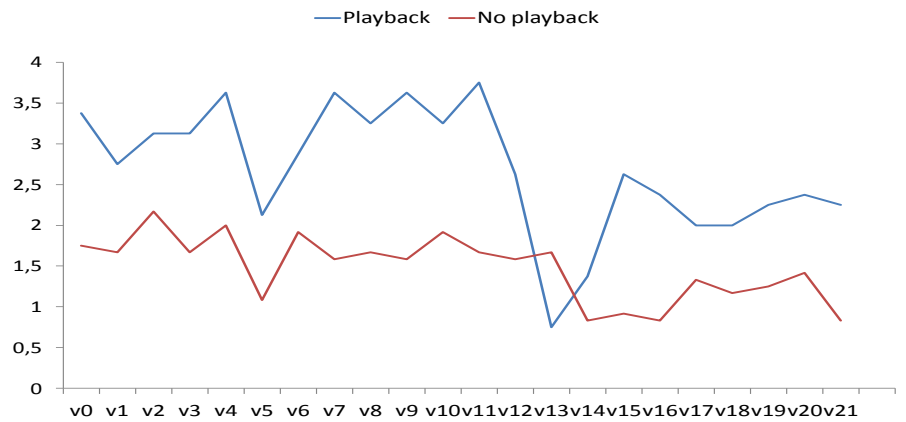

Figure 8. Improvement of study groups in Elgar testing. Separate skills, means of the estimators

The contents of the questions from the estimators are introduced in the skills column in Table 3; they are referred to as separate skills (variables) in the text and tables. When considering the statistical analysis of the separate skills, the difference between study groups in favour of the *playback group* in learning was largest and statistically most significant concerning the variables the *performance as a whole* (v0), *find and communicate the general structure of the music* (v7), *find and express dynamic marks* (v9), *communicate large dynamic changes* (v11), and *use tonally based intonation* (v15) improved faster in the *playback group* than in the other group in statistically significant numbers.

Table 3. The differences between study groups in learning Elgar's *Andante*. Separate variables, means of the estimators. Significances by mixed linear model

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Differences between methods** in favour of playback method	**Significance** of differences Mixed linear model
v0	The performance as a whole	1,63	p=.029
v1 (Tempo and pulse)	Find and keep tempo according to the character and atmosphere of the music	1,083	p=.326
v2 (Tempo and pulse)	Keep the basic pulse throughout the whole piece of music	0,988	p=.414
v3 (Tempo and pulse)	Communicate the tempo and pulse right from the start	1,458	p=.195
v4 (Tempo and pulse)	Express nuances within the basic pulse	1,625	p=.092
v5 (Style and general structure)	Be aware of one's leadership and sustain it throughout the playing	1,042	p=.221
v6 (Style and general structure)	Find the style and atmosphere right from the start	0,958	p=.506
v7 (Style and general structure)	Find and communicate the general structure of the music	2,042	p=.035
v8 (Style and general structure)	Communicate strong musical feelings to the group	1,583	p=.063
v9 (Dynamics and phrasing)	Find and express dynamic marks	2,042	p=.017

v10 (Dynamics and phrasing)	Find and play long dynamic changes	1,333	p=.103
v11 (Dynamics and phrasing)	Communicate large dynamic changes	2,083	p=.026
v12 (Dynamics and phrasing)	Active phrasing and communicate phrasing to the group	1,042	p=.198
v13 (Left hand)	Position and relaxleft hand	-0,917	p=.497
v14 (Left hand)	Motor skills of left-hand fingers	0,542	p=.408
v15 (Left hand)	Use tonally based intonation	1,708	p=.049
v16 (Left hand)	Produce rich sounds with good left-hand finger technique	1,542	p=.113
v17 (Right hand)	Produce appropriate sounds with bow technique	0,667	p=.440
v18 (Right hand)	Singing *detache* bow style	0,833	p=.315
v19 (Right hand)	Communicate the bow style to the group	1,000	p=.325
v20 (Right hand)	Use the bow to express crescendo and diminuendo lines	0,956	p=.172
v21 "Primas" skill	Lead the group by playing	1,417	p=.124

To summarize the results of the study on first stage string instrument students learning the main melody *Andante* from a chamber music composition composed by Edward Elgar: when learning a simple expressive melody that is the leader score in a chamber music composition, the playback support helps the student in comprehending the general view or structure, feeling and style and the characteristic features of the music and, further, finding and informing the others about the appropriate playing style about how to express the atmosphere of the piece of music to be played. In addition to the results discussed above, there were skills that were better in the *playback group* even at the start: communicating tempo and pulse, phrasing and bowing style, knowing one's role as a leader of the group. These results can be connected to Davidson's (2012) finding that the communication of structural features or "meaning" (in narrative composi-

tions) is mediated through bodily movements and facial expressions. In conclusion, communication skills seemed to be born right away in the situation in which there was auditory support for playing a melody score and developed further in the course of playing with the audio support of the notation programme playback.

4.1.2 J.S. Bach's excerpt from *Bauernkantate*: Second violin and violoncello scores

The study design and participants in testing the learning of *Bauernkantate* were the same as in the earlier Elgar study. The scores to be learned were accompanying parts: a second violin or violoncello part of a string orchestra arrangement in baroque style. The second violin score included rhythmic variety, rests, articulation and dynamic marks. The accompanying violoncello part was different from the second violin score because the notating traditions of these instruments were followed (see Appendix 3 and 4).

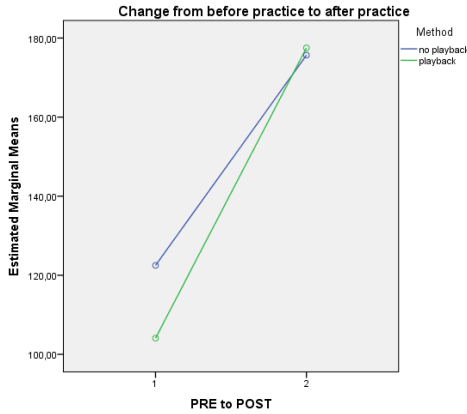

Figure 9. Overall changes in study groups from before practice to after practice in *Bauernkantate* testing. Means of all variables and the two estimators of the performance

In this, as in the Elgar testing, the *playback group* practised the score with the support of the playback and the *no-playback* group practised without it. Again, the results showed that both study groups improved during the practice period, but the *playback group* learned faster (see Figure 9). (Juntunen, 2013; article IV.)

The *no-playback* group was higher through the practice period, but was exceeded by the *playback group* in the end. This finding differs from the results from the earlier Elgar study, where the playback group was better at a much earlier stage of the practice period. This result could be explained by the charac-

ter of the score of the *Bauernkantate*. It was an accompanying score with no clear melodic contour and there were many more details to be read from the score than in the Elgar score. The player might have had to concentrate on reading the details, and the playback with its ongoing pulse might have disturbed the process. Nevertheless, at last, when learning a non-melodic score, the *playback group* improved a bit faster than the other group. According to the general results of learning the *Bauernkantate* score, with the exception of the *left hand* technique, the *playback group* learned faster (Figure 10).

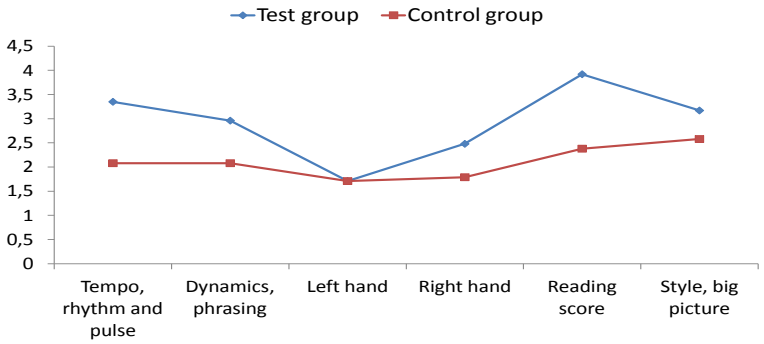

Figure 10. Improvement of study groups *Bauernkantate* testing. Sum variables, means of separate variables and the estimators

As can be seen in Figure 10, the difference between study groups in favour of the playback group is largest in *tempo, rhythm and pulse* and score reading. When analysing the results of the sum variables statistically, the differences were not significant, although *style* and *big picture* was high (p=.052) and *tempo, rhythm and pulse* was also quite high (see Table 4). The result concerning the *style and big picture* is compatible with the results from the Elgar study: students learn general structures and the style of the music faster with audio support than without it.

The difference between the study groups was large in *reading the score*, but the significance was low. However, when calculating the sum variable "reading" again by using more separate variables, such as *read and express dynamics appropriately* (v9) and *reading and playing "terrace dynamics"* (v10) in addition to variables 21-24, the difference between study groups in favour of the *playback group* in learning to read the *Bauernkantat*e score was found to be significant (p=.036).

Table 4. The differences between study groups in learning *Bauernkantate*. Means of separate variables and the estimators. Significances by mixed linear model

Sum variable	**Difference** between methods in favour of playback method	**Significance** of differences Mixed linear model
Tempo, rhythm and pulse	1,27	p=.097
Dynamics and phrasing	0,88	p=.497
Left hand	0,00	p=.269
Right hand	0,60	p=1.000
Reading the score	1,54	p=.323
Style and big picture	0,59	p=.052
Sum variable "reading" Calculated from v9, v10, v21-24		p=. 036

When considering the separate variables, all skills except the left-hand skills improved faster with playback support than without it. The difference in favour of the *playback group* was largest concerning *hold tempo and pulse* (v2), *reading and playing terrace dynamics* (v10), *reading bowings and rhythms* (v23), *keep reading in play-together situation* (v21), *read and play correctly notes and rests* (v24), *read and express dynamics appropriately* (v9), *find tempo and pulse according to the music* (v1), *use appropriate length, speed, press and articulation in bowing style* (v20) *and keep playing in play-together situation* (v22). (See Figure 11 and Table 5.)

It seems that when the score to be learned is in baroque style, the playback supports effectively learning to find and hold the tempo and pulse. A kind of "swing" is characteristic in baroque style, a pulse which, when found, carries on the playing. Learning to read the score seems to benefit from the playback, especially reading bowings and rhythms, notes and rests, dynamic marks. Further, the playback seemed to support using the bow in appropriate articulation, length, speed and press, which is characteristic of the baroque style of the music. Reading or playing on seems not to be disturbed by the playing together situation, which means that the flexibility of the students benefits from playback support in the practice situation. The most outstanding finding was that in *reading and playing "terrace dynamics"* the difference between the *playback* and *no-playback* group in learning the *Bauernkantate* score was found to be significant in favour of the *playback group* (p=.036).

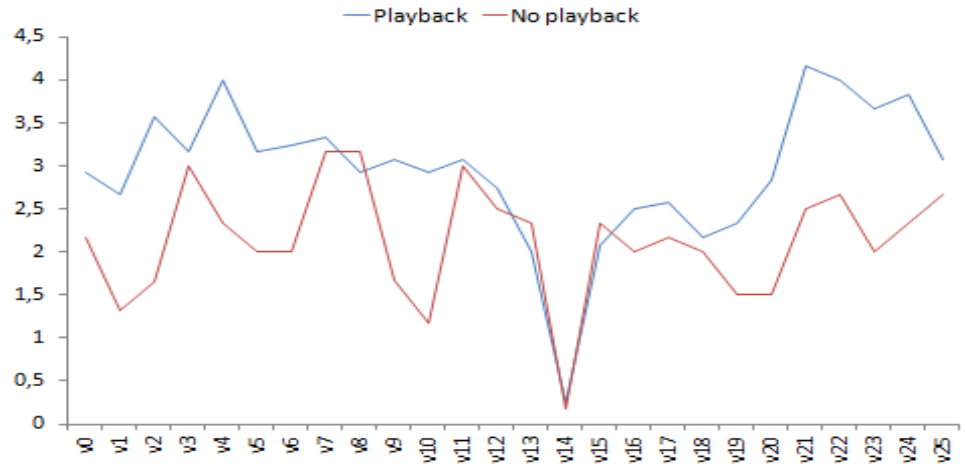

Figure 11. Improvement of study groups in *Bauernkantate* testing. Separate skills, means of the estimators

Unlike in the Elgar study the students in the *Bauernkantate playback group* did not seem to understand the outline of the music clearly better than the *no-playback group.* In fact the *no-playback group* had learned better the skill *adjust the accompaniment score to changes in expression* (v8, see Figure 11 and Table 5). The explanation could be that the first violin score could only be heard from the audio, but the play movements of the leader were not seen. It seems that when playing an accompanying score the interactive together playing must be done in a *live situation* in which the playing of the leader can be seen and followed (see Davidson, 2012).

Nevertheless, the playback support generated an important skill connected with playing music in the baroque style: reading and playing the *"terrace dynamics"*. Using sudden changes of dynamics is perhaps the most typical feature of baroque style music, in addition to *holding the tempo and pulse*. The playback of a notation programme is quite suitable for supporting in practising music in baroque style, because the tempo and pulse remain unchanged, nearly in a "mathematical" way and bowing styles can be specified clearly. Considering that the most outstanding expression in a short and simple piece of music like the recent *Bauerkantate* excerpt is the "terrace dynamics", while finding the general structure did not benefit from the playback support in such large amounts as in the Elgar study, essential characteristics of the music and the playing style were learned better with the playback support than without it.

Table 5. The differences between study groups in learning *Bauernkantate*. Separate variables, means of the estimators. Significances by mixed linear model

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Differences** between methods in learning in favour of playback method	**Significance** of differences Mixed linear model
v0	The performance as a whole	0,75	p=.351
v1 (Tempo, rhythm and pulse)	Find tempo and pulse according to the music	1,33	p=.058
v2 (Tempo, rhythm and pulse)	Hold tempo and pulse	1,92	p=.074
v3 (Tempo, rhythm and pulse)	Playing rhythms in good pulse	0,17	p=.855
v4 (Tempo, rhythm and pulse)	Good timing in changes of notes	1,67	p=.061
v5 (Style and big picture)	Finding the style and atmosphere from the start	1,17	p=.217
v6 (Style and big picture)	Find the big picture of the piece of music	1,25	p=.173
v7 (Style and big picture)	Adjust the nuances with melody	0,16	p=.862
v8 (Style and big picture)	Adjust the accompaniment score to changes in expression	-0,25	p=.839
v9 (Dynamics and phrasing)	Read and express dynamics appropriately	1,41	p=.193
v10 (Dynamics and phrasing)	Reading and playing “terrace dynamics”	1,75	p=.032
v11 (Dynamics and phrasing)	Adjust dynamics to melody score	0,08	p=.913

v12 (Dynamics and phrasing)	Adjust phrasing to melody score	0,25	p=.812
v13 (Left-hand technique)	Intonation	-0,33	p=.716
v14 (Left-hand technique)	Using vibrato in appropriate style	0,08	p=.903
v15 (Left hand technique)	Good fingering technique in legato quavers	-0,25	p=.723
v16 (Left hand technique)	Elasticity in playing large intervals	0,5	p=.579
v17 (Right-hand technique)	Sound quality according to the character of the music	0,41	p=.626
v18 (Right -hand technique)	Good control in *detache* and legato bowing styles	0,17	p=.815
v19 (Right -hand technique)	Good division in bowing technique	0,83	p=.373
v20 (Right-hand technique)	Using appropriate length, speed, press and articulation in bowing style	1.33	p=.151
v21 (Reading the score)	Keep reading in play-together situation	1,67	p=.079
v22 (Reading the score)	Keep playing in play-together situation	1,33	p=.205
v23 (Reading the score)	Read bowings and rhythms	1.67	p=.055
v24 (Reading the score)	Read and play correctly notes and rests	1,50	p=.104
v25	Playing together as an accompanying player	0,42	p=.644

Summing up the results concerning testing first grade participants it was found that when learning a simple expressive melody which is the leader's score in a chamber music composition, the playback support helps in comprehending the general view or structure, feeling and style and the characteristic features of the music and, further, finding and informing the others about the appropriate playing style to express the atmosphere of the piece of music to be played. Further, there were skills that were better in the *playback group* even at the start: communicating tempo and pulse, phrasing and bowing style, knowing one's role as a

leader of the group. In other words, communication skills seemed to be born right away in the beginning when auditory support for playing a melody score was used. These findings are in harmony with *the contents of the examinations and bases for evaluation in violin basic education* stating that the first-grade violin students should find a natural style of playing and be able to create the character and atmosphere of the music and perceive simple musical constructions (The Association of Finnish Music Schools, 2005).

When the score to be learned was a second violin or violoncello part of a baroque style orchestra composition, the first-grade students learned tempo and pulse, reading score and bowing style better with playback support than without it. In addition, although the separate variables connected with figuring the general structure of the piece of music did not confirm the view that playback support is effective, the difference of the sum variable *style and big picture* was nearly significant in favour of the *playback group* (p=.052). Keeping up reading and playing in play-together situation also improved faster in the *playback group*. The most important finding was that, in addition to skill group "reading" (Table 4) expressing fast changes in dynamics, "terrace dynamic" (v10, Table 5), which is one of the most characteristic features in baroque style, improved faster with playback support in significant numbers.

4.1.3 John Barry's *You Only Live Twice*

In the third study described in this dissertation the score to be learned was a well-known theme melody from a James Bond film, *You Only Live Twice*. The film melody as a score to be learned is in harmony of *the contents of the examinations and bases for evaluation in violin basic education***:** in second grade the violin students should learn compositions that contain passages in different styles and atmosphere, playing in different positions, and learn the basics of vibrato **(**The Association of Finnish Music Schools, 2005).

The study design was the same quasi-experimental pre/post design as in the two studies described earlier, but the participants were four second-grade violin students (see player information in Appendix 7). The score was a solo melody and the *playback group* practised it with the support of a play-along CD track and the *no-playback group* without the CD background. The score was written in a special notation style: there were no notes or key marks, only fingering numbers approximately on the places of the corresponding notes. The space between fingering numbers indicated the approximate duration of the notes (see Appendix 5). The aim of the special notation style (see Szilvay Foundation, 2011; Mc Pherson, 2002) was to reduce visual information in favour of musical imagery and rhythmic freedom.

The melody was familiar to all of the violin players in the testing in advance. The score was in second position and the test situation was started by playing the

scale in the same position as the score had been written and the same key with the music. The key signature (Ab major/F minor), had been deliberately omitted to further reduce visual information. Then the students were informed of the notation style of the melody and they didn't think it strange or difficult to read. The students in the *playback group* liked the CD track with its wonderful sounds of a large symphony orchestra.

In general, the audio background seemed to benefit learning crucial features of playing. According to the overall results, the *no-playback* group, again, was higher at the start, but later the *playback group* improved much faster during the practice period (Figure 12). This result is compatible with the earlier Elgar study in which the first-grade students learned a simple first violin score (see Figure 6). The same assumptions might explain the result in this testing as in the Elgar study: the learning strategy is different in the *playback* and *no-playback* group: the flow-like, more intuitive strategy in audio-supported learning might generate faster learning after the familiarizing phase in the beginning of the practice period. Indeed, this assumption seemed to be correct: at the beginning the *no-playback group* was better, but the *playback group* learned faster (Figure 12).

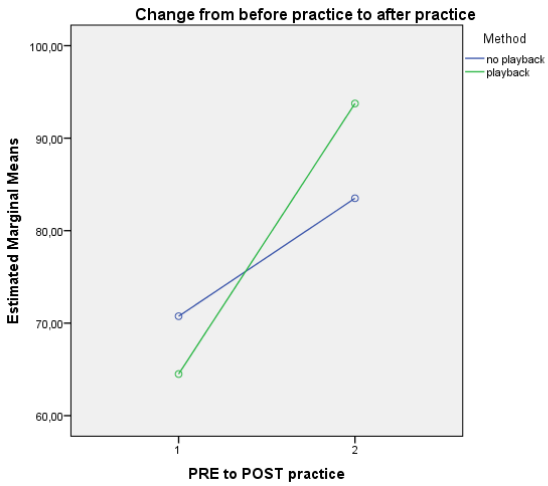

Figure 12. Overall changes in study groups from before practice to after practice in the melody *You Only Live Twice* testing. Means of all variables and the two estimators of the performance

The results showed that all skill groups in the *playback group* improved faster than in the other group (Figure 13).

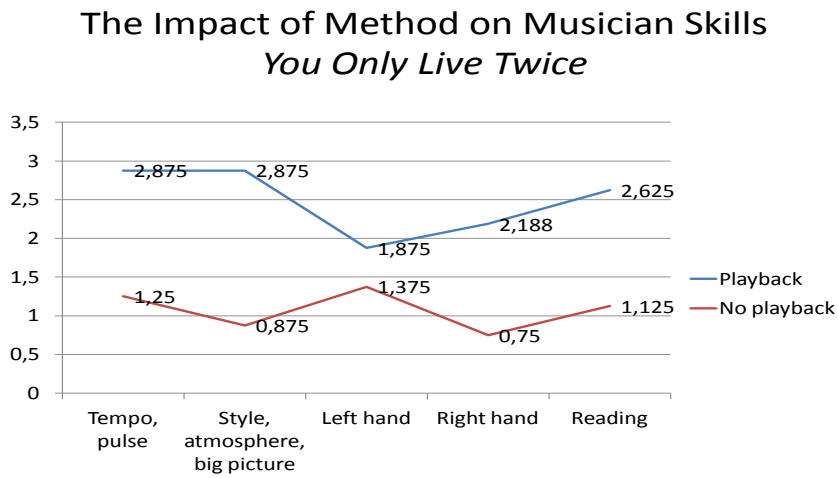

Figure 13. Improvement of study groups in the *You Only Live Twice* testing. Sum variables, means of separate variables and the estimators

According to the results concerning the sum variables, the difference in favour of the *playback group* was clearest in the variable *style, atmosphere and big picture.* This finding, too, is compatible with the Elgar study (see Table 2): in the recent film melody testing the students in the *playback group* could figure the A-B-A structure of the music: the middle passage differed largely from the other parts in its character and mood. In addition, the *playback group* could catch the style and atmosphere right from the start (see Table 7, variable 3). The *right-hand* technique was very crucial in playing this kind of expressive and singing piece of music with long melodic lines. The *playback group* was better in very large numbers (see Figure 13, Table 6).

Table 6. The results in learning the *You Only Live Twic*e score. Sum variables. Second-grade string instrument students

Sum variable	**Difference** between methods in favour of playback method	**Significance** of differences Mixed linear model
Tempo, pulse	1,63	p=.105
Style, atmosphere and big picture	2.00	p=.021
Left hand	0,50	p=.763
Right hand	1,44	p=.040
Reading	1,50	p=.272

While the difference in the sum variable *tempo and pulse* was large but not significant, the difference in the separate variable *managing tempo and pulse through the whole piece of music* (see Table 7, variable 2) was nearly significant (p=.066).

Discussing the separate variables in the film melody study, *the performance* as a whole improved better in the *playback group* in quite large numbers (see Table 7). Further, the *playback group* improved faster than the other group in all skills except the left hand skill *intonation* (see variable 5 in Figure 14 and Table 7), and the no-*playback group* was a bit better. This finding is incompatible with the Elgar study, in which the skill *use tonally based intonation* (Table 3, variable 15) improved better with playback supported practice in significant numbers (p=.049). These findings might indicate that the audio background with a clear-cut harmony base and static rhythm could support intonation in a technically simple melody by supporting the tonal basis. On the other hand, concerning the recent film melody study, while the melody is quite simple, it is technically not easy to play in the second position and the B flat key with good intonation. The glorious orchestra background seemed not to support intonation when learning the recent film melody. The same finding concerns learning an accompanying score *Bauernkantate*: intonation improved better in the *no-playback group* (see Table 5, variable 13): difficulties in reading the score with changing note values and rests could result in inaccuracy of intonation in a playback situation: the ongoing pulse might have disturbed concentrating on intonation.

Concerning the left-hand technique, which does not seem to profit from playback background in general: in this recent study on learning a film melody, (variable 6 in Figure14 and Table 7). It could be supposed that the orchestra background inspired the students to expressive performance by using vibrato in appropriate style (variable 6 in Table 7).

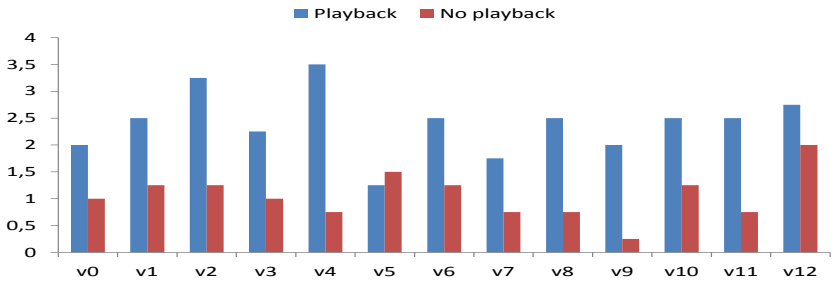

Figure 14. Improvement of study groups in *You Only Live Twi*ce testing. Separate skills, means of the estimators

Considering the separate variables in the light of significances of the differences between study groups (Table 7), the difference in the skill *good technique of singing bow* (v9) is highly significant (p=.005). This skill is essential in playing a melodic and deeply affective piece of music, such as this recent film melody. The difference connected with the variable *master the big picture* (v4) was also highly significant (p=.019). In this particular piece of music it means expressing clearly different atmospheres and characters of the episodes within the piece of music in order to construct a general view or structure of the whole piece of music. The playing skills *characterise the tone with bowing technique* (v8) and *capture the style and atmosphere from the start* (v3) also improved faster with playback than without it in significant numbers (see Table 7). They are both connected with perceiving the feelings of the music from the very start and expressing the style and atmosphere with the singing bowing technique.

Table 7. The results in learning *You Only Live Twice* score. Separate variables. Second-grade string instrument students

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Differences** between methods in favour of playback method	**Significances** of differences Mixed linear model
v0 (The performance)	Performance as a whole	1.0	p=.087
v1 (Tempo and pulse)	Moderately slow tempo. start	1,25	p=.167

v2 Tempo and pulse)	Managing tempo and pulse through the whole piece of music	2,00	p=.066
v3 (Style, atmosphere and big picture)	Catch the style and atmosphere from the start	1,25	p=.048
v4 (Style, atmosphere and general view)	Master the big picture	2,75	p=.019
v5 (Left-hand technique)	Intonation	-0,25	p=.937
v6 (Left-hand technique)	Vibrato in appropriate style	1,25	p=.457
v7 (Right-hand technique)	Adequate tone production	1,00	p=.069
v8 (Right-hand technique)	Characterize the tone with bowing technique	1,75	p=.041
v9 (Right-hand technique)	Good technique of singing bow	1,75	p=.005
v10 (Right-hand technique)	Use left and right hand together in music expression	1,25	p=.235
v11 (Reading)	Read special notation	1,75	p=.172
v12 (Reading)	Create rhythm in special notation	1,75	p=.436

To summarize the results from testing second-grade violin students in learning a film melody *You Only Live Twice*: in general, the melody was learned remarkably better with the support of playback than without it. The *left -hand technique* did not benefit from audio support in general; however, the difference in favour of playback practising was large, but not significant concerning *vibrato in appropriate style.* The *right-hand technique* seemed to benefit from playback, especially the skills *good technique of singing bow* and *characterizing the tone with bowing technique*. Further, *catching the style and atmosphere from the start* and *constructing the big picture* improved faster with playback in significant numbers (See Table 7).

Describing a general view of the results in the three studies discussed, Table 8 introduces the sum variables of all three studies, differences between methods in favour of the playback method and significance of the differences.

The results (Table 8) show that in the Elgar study all skills groups except the right- and left-hand technique improved faster in the *playback group* in large and highly significant amounts. The *communication* skill group, which was essential when learning a leader's score, was higher in the *playback group* with very high significance (p=.003).

Concerning the accompanying score *Bauernkantate*, the variables *style and big picture* and *the tempo, pulse and rhythm of the music* improved quite fast in the *playback group*, but the difference between the study groups was not significant. However, as described earlier, the sum variable "reading" (Table 4) was a bit better and the separate variable *reading and playing "terrace dynamics"* was much better in the *playback group* (see Table 5).

In learning the film melody *You Only Live Twice* the difference between study groups in favour of the *playback group* was even larger than in the Elgar study concerning the sum variable *style, big picture and the atmosphere of the music (*Table 8). Differing from the other two studies, in the film melody study the *right-hand technique* improved better in the *playback group* in large and significant numbers.

Table 8. Results concerning playing skills in articles III, IV and V

The research question (The skill group, sum variables)	**Differences** between methods in favour of playback method **Significance** of differences by Mixed linear model		
The piece of music to be learned (appropriate article in parenthesis)	E. Elgar: *Andante* (article III)	J.S. Bach: Excerpt of *Bauernkantate* (article IV)	Barry: *You Only Live Twice* (article V)
The performance as a whole	1,63 p=.029	0,75 p=.351	1,00 p=.087
The tempo, pulse and rhythm of the music	1,63 p=.029	1,27 p=.097	1,63 p=.105
The style, big picture and the atmosphere of the music	1,43 p=.023	0,59 p=.052	2,00 p=.021
Dynamics and phrasing of the music	1,63 p=.027	0,88 p=.497	
Left-hand technique	0,84 p=.111	0,00 p=.269	0,50 p=.763
Right-hand technique	0,87 p=.114	0,60 p=1.000	1,44 p=.040
Reading the score		1,54 p=.323 (Sum variable p=.036)	1,50 p=.272
Playing together	Communication 1,57 p=.003 (leader's score)	0,42 p=.644 (accompanying score)	

In conclusion, the results of this recent study show that audio support improves understanding the style, atmosphere and general view of the music. When the music to be learned is a main melody in a chamber music composition, the difference between study groups is highly significant. Further, mirroring the *understanding* aspect in learning, also right-hand technique was learned better with audio support than without it when playing an expressive film melody. The second-grade students had understood how to play with *singing bow* and how to *characterise the tone style* (see Table 7, variables 8 and 9) with bowing tech-

nique. Understanding the essential characteristics of the contents of music also leads to better playing *performances as a whole.* It seems that the *Playback Orchestra* method improves playing in an expressive style and communicating the music to other players of the group, and, presumably, to the audience, as well. Accordingly the playing will be in a good shape for a concert, which is one essential goal for practising the music.

4.2 Playback support in learning improvisation

The study on learning improvisation (article VI) was born as a "by-product" from testing the learning of a long musical tale, *Mickey Mouse in Storm* consisting of several episodes in different atmospheres and playing styles. When exploring the results of the *Mickey Mouse* study it was found that there was no difference between the study groups, with one clear exception: *improvising storm* in a short passage improved much faster in the *playback group* (Juntunen *et al*., 2015). Hence, the estimators were later asked more detailed questions concerning the improvising performances in the short improvisation section. The evaluations were made from video clips which had been cut from the original *Mickey Mouse* study.

At the beginning of the first situation of the *Mickey Mouse* testing, the students made playful exercises by playing "stormy" sounds with their instruments. After that, all students were given a printed score of the *Mickey Mouse* music and the scales in the relevant keys were played. Then the author played the score together with every student; the *playback group* played with the support of a notation programme playback system and the other group without the playback. At the start of the "storm passage", the students were told to improvise storm effects. In the improvisation passage the *playback group* heard sound effects from the computer in the background; the *no-playback group* improvised together with the author who played violin (Juntunen *et al*., 2015).

The improvisation research was a qualitative case study combined with quasi-experimental tests and quantitative analyses. The estimators were the same as in all other studies described in this dissertation and the students were ten first-grade string instrument students (see Appendix 6). In the recent improvisation study the evaluations were made with VAS (visual analogy scale, see Vehkalahti, 2008; Van Roo *et al*., 2011), because this method was thought to be more suitable for evaluating the improvisation performances than the numerical evaluation style used in the other three studies. According to the quantitative analysis made with SPSS 22 and the general linear model, the group that did not use playback was evaluated to be constantly better, but the *playback group* improved much faster (see Figure 15).

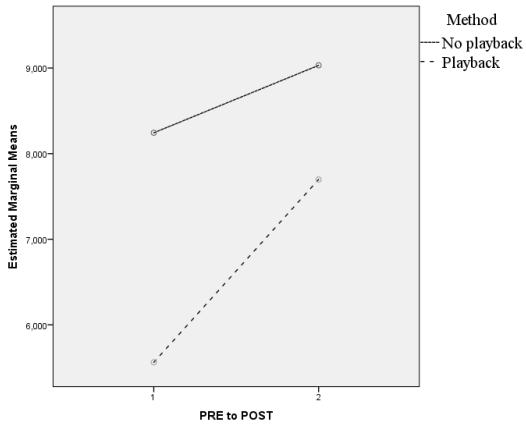

Figure 15. Improvement in improvisation during practice. Means of all variables and the two estimators

This overview of the results in Figure 15 is in line with the three studies described earlier: the group that uses playback support is estimated lower in the beginning, but improves faster during the practice period than the other group (see Figures 6, 9 and 12). However, in this recent improvisation study, the *playback group* does not exceed the *no-playback group* although it improves faster (Figure 15).

Nevertheless, using the means of all players and the means of the two estimators (Figure 16), it was found that the *playback group* had improved faster in all the improvisation skills evaluated by the estimators. The difference in favour of the *playback group* was large in variables concerning *flow and atmosphere*, *concentration* and *joy of playing* (Figure 16). This finding is compatible with the three studies described earlier: finding the atmosphere of the music is easier when playing the musical tale *Mickey Mouse in Storm* with the support of an audio of the whole music and improvising a passage as a kind of expression of feelings after that. Feeling the atmosphere could be thought to give a kind of "flow" experience (Csiksentmihalyi, 1996) in the playing situation and intensify the concentration, thus creating the joy of improvisation.

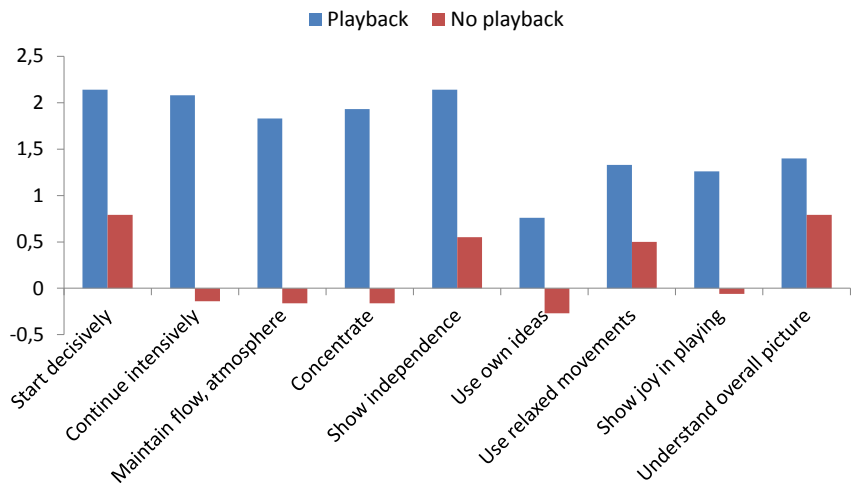

Figure16. Improvement in improvisation skills. Means of the players and the two estimators

Note: Players Five and Six are not included in the calculations in Figure 16.

The most interesting finding is that the *continue intensively* (Figure 16) in the improvisation performance had improved in the *playback group* much faster than in the other group. This finding is in harmony with Burnard's research: the improvisers aim at continuing the playing fluently and logically (1999, 2002). An improviser can be seen as a kind of story-teller, having a determined style of carrying on the storyline from the beginning through the whole story to a logical and plausible end (Juntunen *et al*., 2015).

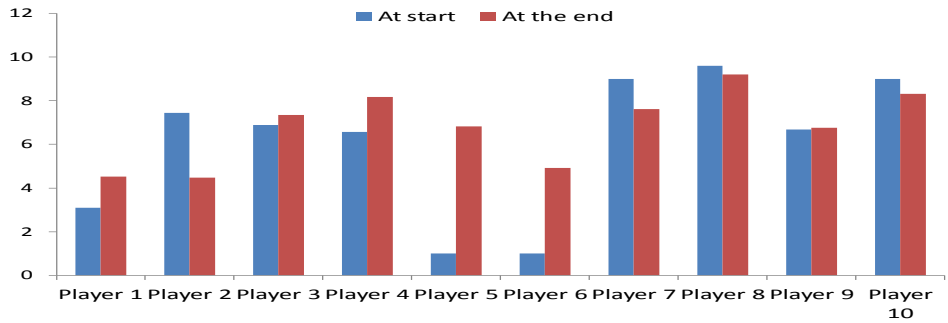

Figure 17. Improvisation skills of all players before and after a practice period. Means of all variables and the two estimators.

Because there seemed to be large individual differences among the players even at the beginning of the testing period (see Figure 17), it was found reasonable to consider the learning results of the students from a wider point of view. Two players who did not improvise at the beginning at all (players 5 and 6) were on the same level with the others at the end, whereas two players who were good at the start (players 2 and 7, see also Appendix 6) were not so good at the end. A girl who has motor problems (Player 1) was later much better in every skill especially on *intensive continuity* and *joy of playing*.

Summing up the findings of all the studies described above: the element that benefits from audio support in all three studies concerning Elgar's *Andante*, J.S. Bach's *Bauernkantate*, John Barry`s *You Only Live Twice* and the recent improvisation study is connected with figuring the *style, atmosphere and general structure* of the music. The difference between study groups in favour of the *playback group* is significant (Elgar p=. 0.23, *You Only Live Twice*=.021) or nearly significant (*Bauernkantate* p=.052). In the improvisation study it was thought not to calculate the significances because the differences between the students seemed large. Nevertheless, in improvisation study, as well, it was found that the variable connected with *flow and atmosphere* improved clearly faster in the *playback group* than in the *no-playback group* (Figure 16).

Based on these findings, it can be concluded that the flow-like learning strategy generates an insight of the general view, style and atmosphere of the music especially if the music is a main melody. These musical elements can also be communicated to others (see Table 3, variable 7, p=.035). The image of the style and atmosphere can be found out right from the start (see Table 7, variable 3, p=.048) and mastering the big picture of the music improves clearly and in highly significant numbers better in the *playback group* than in the other group (Table 7, variable 4, p=. 019).

Concerning further the improvisation research, when exploring the differences between the students in general, it seems that the players who get high scores in examinations (see Appendix 6, players 3 and 8) are also good improvisers both before and after the practice period. Accordingly there is no clear (Figure 17, player 3) or slightly negative improvement (Figure 17, player 8) during the practice period. From these findings it might be concluded that the high musicianship qualities of these players are apt to generate both good musical communication skills and improvisation by nature, as manifestations of musical ability and imagination. On the other hand, a student with a bit lower capacity (Figure 17, player 1, see also Appendix 6, player 1) and motor disturbances can improve largely on every improvisation skill, especially in *continue intensively, maintain flow and atmosphere and show independence.* Furthermore, players 5 and 6 who did not improvise at all in the start improved with playback background during the practice period nearly to the same level with others (Figure 17). Players 2 and 7 played a good improvisation in the begin-

ning, but they were not so good later. It seems that these players find that the storm improvisation was "done"; it was a unique performance and repeating it was not a good idea (compare Peck, 2013, 27-28).

When exploring all the videos from the improvisation tests it seems that the most natural and creative improvisations arose from playing alone with no audio background (Figure 17, player 7) and improvising together with an advanced violin player. Further, it seems that the *storm effects* from the computer did not inspire students to improvisation and that the ongoing pulse in the playback during the improvisation passage disturbed and did not give enough time and space for creative music making. This could be the explanation for the result that the playback group was lower through the whole testing period (Figure 15).

Nevertheless, all the improvisation skills improved faster in the *playback group* than the other group (Figure 16). Accordingly, the answer to the research question, "Does learning a musical tale with audio background support learning improvisation?" could be "yes". The results could indicate that learning the whole *Mickey Mouse in a Storm* musical tale with audio background created a richer imaginary basis for improvising a storm than practising the composition without the audio background. The story of *Mickey Mouse* struggling in a storm with the formidable gnome on the sea was created in a vivid and effective way with musical elements in the background playback: large changes in dynamics, keys, different bowing styles (tremolo, staccato) and intensive harmony.

4.3 Conclusions of the results

The aim of the recent research was to learn if string instrument students learn new orchestra and chamber music scores better with or without the support of an audio background. The effectiveness of the technology-based method using the playback as a support, *Playback Orchestra* method, was tested with a quantitative approach by a pre-post study design; the results were then analysed with the SPSS program 22 and mixed linear and general linear models. As far as learning improvisation was concerned, a qualitative approach was applied: observations of personal features of the students and descriptions of some improvising situations were used to gain a larger and deeper view on the nature of the learning processes. The skills chosen to be evaluated in the testing were compatible with the guidelines of the *extensive curriculum of music education, contents of the basic examinations* and *bases of evaluation in violin education* (see Finnish National Board of Education, 2002) and also with the new curricula of some music institutes (see The curriculum of the Conservatory of Kuopio, 2014). The questions that the estimators were asked were also based on the information expressed by two string instrument teachers concerning the musical and technological challenges of the score to be learned (see Appendix 8-10).

There is a saying, "cannot see the forest for the trees", which means understanding the details more than the larger picture or being unable to see systems behind what is normally detected. When interpreting the results from the analysis of data, it seems that the skills connected with creating an overview of the structure, style and atmosphere of the music benefit most from the audio-supported learning situation. This finding concerns especially the studies in which the score to be learned was a main melody in a chamber music composition (Juntunen *et al*., 2013, 2014). The results also showed that first-grade string instrument students learned communication skills faster with playback background than without it in highly significant numbers. The piece of music to be learned was a short melody (Appendix 1 and 2) with a clear-cut melody line and structure supported strongly by the harmony. The main melody for second-grade students was a bit more difficult than the one used for first-grade students, a theme melody of a James Bond film (Appendix 5) and was known in advance to all the players. The results concerning this film melody showed that mastering the general structure, style and atmosphere developed significantly better in the playback group (Juntunen *et al*., 2014).

Although teaching the specific instrument technique skills is not the main target in *Playback Orchestra* method, it seems that learning right-hand technique and learning to use the bow benefit from the audio background. Accordingly, playing the film melody with a fine orchestra background CD track made the students play with good technique of singing bow and to characterize the tone with bowing technique (Juntunen *et al*., 2014); the difference in favour of the *playback group* was statistically significant. In general, the left-hand technique seemed not to profit from the audio background, with the exception of tonally based intonation (see Table 3, variable 15; Juntunen *et al*., 2013). In the film melody study, *vibrato in appropriate style* (Table 7, variable 6) improved clearly faster in the playback group, but the result was not significant. In fact, when the score to be learned was a second violin or a violoncello part of music in baroque style (Appendix 3 and 4), intonation and fingering technique improved even faster in the *no-playback group* (see Table 5, variables 13 and 15; Juntunen, 2013). Nevertheless, the sum variable *style and big picture*, concerning also this accompanying score the difference between study groups in favour of the *playback group* were, again, nearly significant (p=.052, see Table 4: style and big picture). The most interesting finding was that the most outstanding character of baroque music, "terrace dynamics" was learned faster with playback in significant numbers (p=.032, see Table 5: variable 10; Juntunen, 2013). Thus, also in the case of accompanying scores, the features connected with understanding the musical contents improved faster with audio support than without it.

A general result of the improvisation study was that although all the skills evaluated by the two estimators developed faster in the *playback group*, the computer effects during the improvisation passage did not seem to support learn-

ing improvisation. When exploring all the videos from all test situations, it was found that *free improvisation alone* without any audio background and also *improvising together with an advanced player* without computer background seemed to be a good environment for learning improvisation in a natural and creative style. To try to explain these a bit contradictory results, it could be figured that while the computer background with its machine-like procession took the time and space needed in improvisation, it did not support improvisation, but the inspiration for the *playback group* was based on the musical tale*, Mickey Mouse*, which was practised with the audio background. The tale was told with *musical elements*: harmony, dynamics, key changes and playing styles; it could have inspired the players to improvise in a concentrated, joyful style and created a feeling of good atmosphere and flow in the improvisation, as the results showed. The finding that *intensive continuity* in the improvisation improved better in the *playback group* in large numbers (Figure 16; Juntunen *et al*., 2015) might be connected to the research of Pamela Burnard: the improvisers aimed at creating a storyline for coherent and convincing musical story by "playing as it comes", as Burnard (1999, 2007) put it. The improvisers created a coherent story to describe a storm and told it with concentrated and intensive playing; they were good story-tellers (see Figure 16; Juntunen *et al*., 2015). As a conclusion of the results from the improvisation study, it can be said that while the computer effects did not support learning during the improvisation passage, playing the whole musical tale with playback could inspire and generate better improvisation than playing the *Mickey Mouse* piece without it. However, in a larger view, improvising without background on one's own time and pace, and improvising together with a more advanced player were better environments than improvising with the playback background.

The findings, especially concerning the improvisation, could be seen in the light of John Sloboda's thoughts on the "meaning of music". According to Sloboda (1998), the understanding of musical contents is principally born with experiencing the dynamic processes, sensations of tension and resolution, growth and decay and anticipation in the procession of the music. The dynamic feelings are the "flesh and the blood which give life to the skeleton" (Sloboda, 1998). It is clear that building the "structure" of music is not the principal aim of composers; rather the core of interest is in the contents, which includes musical tensions and resolutions built by the themes and harmonic processes, which in turn generate the structures; in classical music the structures are quite clear-cut and easily identifiable. Metaphorically speaking, by knowing the personality of the "wanderer" (music style), the style of behaviour and the environment in which the wanderer moves (a simple and short or a longer composition), a listener can predict in which direction the wanderer (music) is going (melodically and harmonically). It can be predicted, as well, which are the waypoints in the structure and also predicted when the music will it arrive at the destination.

Further, Sloboda (1998) considers that in the same way as for understanding music, the tools for interpreting it are born with "being a biological human inhabiting in a physical and social world who uses repeated application of increasing force and a sudden release of whatever was holding the obstacle in place". Sloboda continues further: "The actual bodily process of interacting with an instrument in a real physical environment makes this analogy directly available to the performing musician. Accordingly, a musical performance could be one in which the performer recognizes the dynamic implications of the structure and enhances the musical performance in such a way as to highlight those implications" (Sloboda, 1998). In other words, the charming and interesting view on the origins of musical performance stated by Sloboda implies that understanding music needs awareness of the musical processes and its relationship to each other and a view of the constructions in the music. The musical performance can be thought to be based on the dynamic understanding of the contents of music and on bodily interaction with the instrument, which in turn are connected with the physical world: pushing, lifting and moving objects using the appropriate direction and power. It is also easy, although a bit controversial to the ideas of technology-based learning in the recent research paper, to agree with Sloboda who states that, "This is probably why computer music often sounds "inhuman". Its creators are not bound by the constraints that bind musicians interacting with real instruments in real time using real human bodies!" (Sloboda, 1998.)

In light of the main results of this study, the research literature was explored to find links and bases for interpreting them. Which kinds of activities and mechanisms could be in the background of learning musical structures, atmosphere and style, playing in a good style with play movements which are clear and expressive when leading a group by playing? Are those mechanisms connected with memory mechanisms and imagination, "musical imagery"? After considering and exploring the background phenomena, a fictive model was constructed to try to describe learning music in an audio supported environment: a *gearwheel model*. In this model all parts are connected to and interactive with each other and activity in one part has an influence on all the others instantaneously. In a sequential process, the understanding of the music by hearing leads to more and more appropriate playing movements and anticipation in reading the score and playing the music. The gearwheel model is a metaphorical description of audio supported learning of music.

4.3.1 A gearwheel model of learning music with audio background

Because of the results from the recent research on the impact of the *Playback Orchestra* learning method, it seems that students learn essential features of the music to be learned: the style and atmosphere and the structure of the music. When playing along with the playback they also learn the timing of play movements, especially the bowing movements, on the basis of the ongoing pulse of the audio. The quality of play movements and bowing style is learned to be in harmony of the understanding of the music evoked by hearing the whole music when practising one's own part.

In light of the recent and earlier research on learning new music, it seems possible to consider a metaphorical model on learning to play with audio support. Figure 18 introduces a "gearwheel model" to describe the interaction of the elements taking part in the learning process.

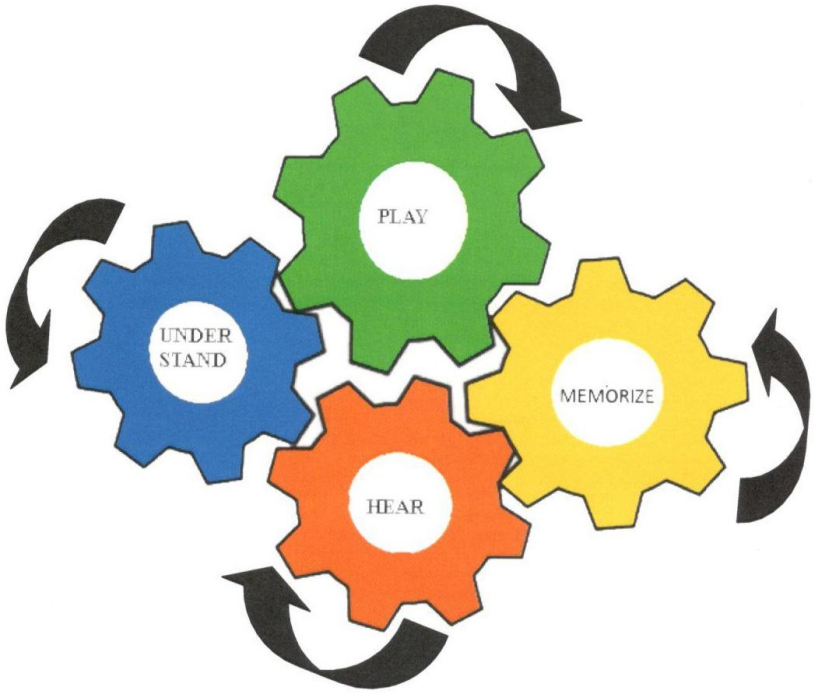

Figure 18. A "gearwheel model" of playback learning.

According to the basic ideas of the "gearwheel model", understanding the music is the crucial factor in learning. Rather than sight-reading, the understanding is based on hearing the music with its rhythms, tempos, harmonies, dynamics and

articulations. When understanding the music, the musicians play in harmony with the contents, style and atmosphere of the music and the play movements express the musical content. Further, it could be considered that the playing actions connected with hearing, playing, and also connected with reading the score, might be repeated involuntarily in the musical memory thus strengthening the musical image of the piece of music and the appropriate playing actions. With repeated listening and playing situations, the player hears more and more details of the musical content, the playing movements become ever more appropriate to the music and the process helps to anticipate while reading the score. The mistakes are avoided in advance which contributes to rapid learning. This kind of use of aural assistance can be seen as learning by "hearing eye" and "seeing ear" (Beckman, 2011). The hearing eye can look at the score of a piece of music and, at the same time, hear it in mind and on the basis of this understanding, reproduce it with the instrument. The seeing ear can imagine or produce the notation of the piece of music when hearing the score. Finally, the "feeling body", describing body language, could perhaps be added to this discussion.

The musical content and the ongoing pulse of the playback support the timing and quality of play movements, especially of the whole body and right hand, thus generating a playing style that is informative for co-players. This could mirror the notes of Tauriainen *et al*. (2012): playing with a rhythm section helps players internalize the pulse of the music. The role of play movements, body language and facial expressions is highlighted in the *Playback Orchestra* method: it was found in the main melody tests (see Figure 7 and Table 2); the *communicating* through clear and expressive play movements advanced effectively with playback supported practising. In a sense, playing music can be seen as "dancing the music" (see Schutz *et al*., 2012), with the ongoing pulse supporting the timing of the movements. The relationship between music performance and dance is so prominent that some have hypothesized they may have originated as a single system of communication (Hagen *et al.,* 2003). In future research, the properties of play and movements characteristic of learning with playback support could perhaps be studied by using video analysis.

Traditionally, there is a hierarchy inside playing groups: in a chamber music ensemble a more dominant player shapes the less-dominant individual's interpretation and movement patterns in a dance-like interaction. Concerning the repertoire of movements used, Davidson (2012) mentioned *swaying* as an overall expressive device used by the instrumentalists. This result reflects some earlier research (Cutting *et al*., 1978, 1981) in which it was found that swaying or swinging gestures and smaller movements such as a raised eyebrow or a hand lift are used as expressive movements.

There are numerous instances of research on body motions, gestures and facial expressions connected with musical performances. For instance, it has been

found that when asked to move freely while listening, a player's movements of the extremities tend to synchronize with faster metric levels, whereas movement of the torso tends to synchronize with slower metric levels (Toiviainen *et al.,* 2010). Further, body motions are considered to be closely intertwined with aural images and timing in music (Honing, 2003); perceiving musical ideas is often connected with the whole-body motion of performers (Davidson *et al.,* 2002; Dogantan-Dack, 2006; Juslin *et al.,* 2006; Lapidaki, 2006). Wanderley *et al.* (2005) distinguish between two classes of physical gestures: *effective gestures* that are required for sound production (i.e., playing movements) and *ancillary gestures*, which are not necessary for the creation of sound. *Ancillary gestures* have also been referred to as either expressive movements (Davidson, 1993) or body language (Dahl *et al*., 2007). Ancillary gestures seem to some extent to be involuntary and unpreventable: the pianist in Huang's test was asked to vary his playing as little as possible, but he was not able to consciously control the secondary gestures (Huang *et al*., 2011). This could be analogous to studies in social psychology: activating the facial muscles associated with smiling produced higher ratings of amusement from other people, even without participants' conscious awareness of smiling (Strack *et al.,* 1988). In conclusion, the style of body movements of a player are born involuntarily on the basis of understanding the music and the player can express it with play movements to the co-players.

In addition to communication between co-players, it has been found that there are also subtle interactions between performers and the audience based on perceiving the movements and expressions of the performer connected with posture, gesture, emotion and meaning (Gellrich *et al.,* 1991). Davidson (2012) found that the compound movements of the body and facial expressions offer audience members an insight into the articulation of musical structures as well as the narrative of an underlying meaning of the work. In a study (Silveira, 2014) concerning the body movements of a professional chamber ensemble performance, listeners were asked to rate each performance on the basis of perceived appropriateness of style and perceived expressivity of the movements. The results indicated that body movement did significantly affect listeners' ratings: increased movement corresponded to higher ratings. However, music majors rated consistently all the performances relatively lower than the non-music majors, perhaps suggesting a higher level of discrimination than non-music listeners (Silveira, 2014).

In conclusion, the body movements of players have many kinds of effects on other players and the audience. Silveira's (2014) results are consistent with previous research suggesting that visual stimuli can affect listeners' perceptions of musical quality (Gillespie, 1997; Liao, 2008; Madsen, K., 2009; McLaren, 1985; Morrison *et al*., 2009; Price, 2011; Van Weelden *et al.,* 2007; Wöllner *et al..,* 2008) and that performers' body movements influence the listening experience (Davidson, 1993, 1994, 1997, 2001; Davidson *et al.,* 2002; Juchniewicz, 2008).

Interestingly, there is growing evidence that ancillary movements do in fact influence the way a performance "sounds" to the listeners: soft movements make the performance sound softer, rough movements increase the impression of robust sounds (Wanderley *et al*., 2005).

Concerning the metaphorical "gearwheel model", in addition to the elements like understanding and play movements, the memory element is also very interesting and challenging. The memory mechanisms behind learning music could be thought to include imagery that covers auditory items, in other words: *auditory imagery*. According to Hubbard (2010), although there are many empirical findings concerning learning mechanisms that might be based on *auditory imagery* and its properties, there does not seem to be a general theory (Hubbard, 2010). One definition of *auditory imagery* is provided by Intons-Peterson (1992) stating that auditory imagery is "the introspective persistence of an auditory experience, including components drawn from long-term memory, in the absence of direct sensory instigation of that experience" (Intons-Peterson, 1992, 46). In other words: there seems to be auditory experience concerning music without the physical sounds, and some components are drawn from long-term memory. This indicates some kind of model of the music to be born with hearing the music.

4.3.1.1 Auditory imagery and learning music

Nonvisual forms of imagery are common and useful in everyday life (e. g., see Eardley *et al*., 2006); they make actions anticipatory in the same way as using visual imagery of a "map" when walking in the city helps to avoid the wrong routes. Mental imagery has been studied both by objective measures and by self-report, with most researchers focusing on visual imagery, but only a few imagery studies consider auditory imagery. However, well known and distinguished music researchers have pointed out the role of imagination in musical activities and learning. David Elliott (1995) states that listening to music leads to processes by which a person sees images of hidden musical constructions based on the repetition of themes, figures and other musical characters (Elliott 1995, 86–87). Further, as Zoltan Kodaly claims, improvement in musical abilities depends on how a person imagines and hears sounds (Kodály, 1974, 186–200).

According to Hubbard (2010), the experience of imagery is subjective; thus, its existence and properties must be inferred from indirect measuring of phenomena that are hypothesized to be influenced by imagery in predictable and systematic ways (Hubbart, 2010). Recently there seems to be a research tool suitable for studying auditory imagery: the Bucknell Auditory Imagery Scale (BAIS). It is a short self-report measure encompassing both Vividness and Control subscales for musical, verbal and environmental sounds. According to Halpern (2015), the tool has high internal reliability, no relation to social desirability and only a modest relation to musical training. Pfordresher *et al*. (2013)

also found that the BAIS research tool predicted well the singing in tune performances of "poor-pitch singers" and the same result was found concerning "poor vocal imitators" (Greenspon *et al.,* 2013). It also predicted performance in another active imagery task in which the participants were given a starting note and they had to decide whether the next note would move up or down in scale steps by using arrows "up" or "down". The participants who succeeded well on the task indicated that they used a pitch imagery strategy, and the prediction, using BAIS, of their performance was good (Gelding *et al.,* 2015).

The interaction between visual imagery and auditory imagery, working memory, musical processing and rehearsal have been studied (Tinti *et al.*, 1997; Crowder, 1989; Cupchik *et al*., 2001; Halpern, 1988a, 1988b). In addition, research on the relationship of the brain and auditory imagery has been rapidly increasing, and strong brain electrical activity has been found in studies, in which the participants are instructed to form an auditory image during a gap in the continuation of music (Janata, 2001; Meyer *et al*., 2007). Further, inner "hearing" is accompanied by identifiable changes in cerebral blood flow (Halpern *et al*., 1999; Zvyagintsev *et al*., 2013) and neural electrical signal activity (Schaefer *et al*., 2011). It has also been discussed that auditory imagery seems to involve many of the same brain areas as auditory perception. Brodsky *et al.* (2003) found that processing of notated music was influenced by a concurrent stimulus or task that engages the same mechanisms that were used in audiation: kinaesthetic-like phonatory processing mechanisms. A later study (Brodsky *et al.,* 2008) showed that the pattern of sub-vocal muscle activity was much more dynamic during silent reading of visual notation than during control tasks.

To better understand the brain mechanisms behind auditive processes, cognitive neuroscientists have begun to employ brain imaging technologies (Zatorre *et al*., 2005). In the study by Herholz *et al*., (2012) fMRI results revealed that a network consisting of right anterior superior temporal gyrus and the right dorsolateral prefrontal cortex was active during encoding of imagined melodies. It seems to make sense that imagery would be mediated by a connection between a secondary and a working memory area (Halpern, 2015); further, it was found that cerebral blood flow in both those areas was higher among people with higher scores on the BAIS (Herholz *et al*., 2012). In addition, one area of left temporal pole was more active concerning participants with vivid images during recognition of previously heard melodies (Herholz *et al*., 2012). The final example of research on brain and imagery comes from a structural study (Lima *et al*., 2015) in which a large sample (74) of individuals participated in a passive listening task of different kinds of human vocal sounds during fMRI scanning. Higher BAIS scorings correlated positively with gray matter volume in several areas, including the left inferior parietal lobule and left supplementary motor area (SMA). Both areas have been implicated in functional studies of musical imagery (Halpern *et al*., 1999; Zatorre *et al*., 2010; Foster *et al*., 2013).

Imagination and images evoked by hearing music belong to everyday experiences and learning situations. Bailes (2007) studied the prominence and nature of musical auditory imagining in the lives of music students and found that the majority of students described having repeated musical fragments in mind and the music could generally be identified by name. In a study based on reports from participants, Leaver *et al*., (2009) found that an image of a familiar CD track was reported during the subsequent silence when listening to the recording, but no such image was reported when the track was from an unfamiliar CD. This finding is consistent with the effects of familiar or unfamiliar music on auditory imagery during a silent gap in music in the research of Kraemer *et al*. (2005), help in learning (Walters 1992, 535) and teaching music (Pembrook *et al*., 1986, 1–21). In conclusion, music with which a person is familiar tends to be repeated in mind under certain circumstances helping to orientate when practising to learn to play them.

Referring to research, the hypothesized musical image might preserve many structural and temporal properties of auditory stimuli in addition to the melody. Results of the matching and judgment tasks suggested that auditory images could also contain information on loudness (Intons-Peterson, 1980; Intons-Peterson *et al*., 1992) and pitch (Intons-Peterson *et al*., 1992b). It has also been found that the timbre of tones has an influence on observing pitches (Crowder, 1989). Auditory imagery also seems to preserve tempo information in a constant way (Halpern, 1988 b). The most interesting view afforded by the hypothesized existence of images which retain musical information is anticipation: on the basis of images one can "predict" what is coming next in music. This is crucial when learning music in a complicated situation: of reading and playing new scores at the same time. Indeed, images involving expectation of the music's progress are found to facilitate perception when the stimulus to be perceived matches the expectation and, conversely, interferes with perception when the stimulus to be perceived does not match the expectation (e.g., Janata, 2001; Janata *et al.,* 2006).

To summarize the research and discussions just described, the general view of music (the big picture) containing the structure, key, rhythm, tempo and pulse could be thought to be "images" that support anticipation when reading and playing a new piece of music. According to the results of this recent study, figuring the general view of the music was found to benefit from playback learning in clear numbers (see Figures 8, 11 and 14, Tables 4- 8). When considering processes behind this result, the views of the Ahonen (2000) research could be appropriate. Ahonen noted that the understanding of tonal music is based on the knowledge of the relationships between the functional activities of the music. In tonal music, which was the case in the recent study, the minor or major key is the frame within which the music lives and in a melody, in addition, each note tends to act in a certain predictable way: increasing tension or movement or

striving for rest or peace (see also Sloboda, 1998). The seventh note of a tonal scale is the most active: it strives to go up to the tonic. The tendencies in harmony are even stronger than in melody: *tonica* is static; *dominant* is full of energy and *subdominant* expresses soft and lyrical status. It could be figured that after having learned the structure and functional tendencies of a piece of music while listening, some expectations are evoked concerning the direction of the melody and succession of chords striving to reach the "home", tonica (compare Ahonen, 2000; Krumhansl, 1990). Further, as Sloboda (1985, 188) points out, knowledge of tonal constructions may help in perceiving rhythm characters and constructions as well.

In addition to the tendencies in harmony and melody (compare Sloboda, 1998), there might be organized models that have come into existence during years of listening to different styles of music. The music style or genre might be such an image: "a march", "baroque music", or "a traditional simple melody" or an expressive film melody". Matching the audio of the piece of music with those "models" learned earlier supports playing in good style (see Figures 7 and 13, Tables 2-8), and learning the appropriate bowing style and technique (see Figure 13, Table 6 and 7).

Music educators should pay attention to the view that the ability to find musical contents is not necessarily born with formal training; it may also be a manifestation of innate aptitude. Some research concerning the capacity for processing Western music is reviewed by Bigant *et al*. (2006). They investigated perceiving musical tensions and relaxations, generating musical expectancies, integrating local structures in large-scale structures, learning new compositional systems and responding to music in an emotional (affective) way. The overall set of the data found highlights that these capacities reach also in untrained listeners such a degree of sophistication that they are enabled to respond to music as ''musically experienced listeners'' do (Bigant *et al*., 2006).

Considering the "gearwheel model" in light of the discussions and research presented above, it could be considered that auditory imagery once generated might operate like mnemonics by its tendency to involuntarily repeat music in the mind (compare Bailes, 2007 and Leaver *et al*., 2009). The experience of "hearing" music in one's head has been found to be phenomenologically strong (Crowder, 1989; Cupchik *et al.,* 2001; Halpern, 1988a, 1988b), accordingly listening to a full score of an orchestra composition, the student's memory mechanisms might retain a rich image of the music including the tempo (see Halpern, 1988 b), atmosphere and feeling, rhythm patterns and tonality. Taken that musical images connected with the "inner ear" involve expectation, they facilitate perceptions of stimuli that match the expectation (Janata, 2001; Janata *et al.,* 2006). This in turn leads to smart anticipation of the appropriate future playing and reading actions and help to avoid mistakes in advance. This, again,

is the basis for faster learning with audio supported practising than without it, which was largely verified in some parts of the testing data.

4.3.2 Flow-like learning strategy of musicianship skills

Using the *Playback Orchestra* method, the orchestra students learn musicianship skills by practising in orchestra musicians' style: *letting go* together with the playback and correcting mistakes and the play technique afterwards. Accordingly, the learning strategy when using the *Playback Orchestra* method is in harmony with live orchestra rehearsals: holding on playing without stopping when mistakes occur, listening to others, following the pulse and playing style informed by the conductor. When practising orchestra scores with the "virtual orchestra" of the playback, the students learn quickly to play correctly and in good pulse. The playing and behaviour of the orchestra students seems to resemble the *Optimal Experience* or *Flow* phenomenon stated by Csikszentmihalyi (1999): it is playing in a relaxed and joyful style when "letting go" while playing. In music making this experience could be said to occur when a new or difficult progression in music has been mastered or when everything comes together after a long and difficult rehearsal (Csikszentmihalyi (1999). The playback background makes those efforts more fun and motivating. According to Csikszentmihalyi *et al*. (1992):

> When goals are clear, challenges are matched to skills and accurate feedback is forthcoming, a person becomes involved in the activity. At this point, concentration focuses on what needs to be done. [Accordingly] climbers, concentrating on their progress have no attention left over for anything else. Violinists must invest all their psychic energy in feeling the strings and the bow with their fingers, following the notes on the score and the notes in the air and at the same time feel the emotional content of the piece of music as a whole. [In flow experience] irrelevant thoughts, worries, distractions no longer have a chance to appear in consciousness. There is simply not enough room for them. Self-consciousness, or the worry we so often have about how we appear in the eyes of others, also disappears. Because the activity forces us to concentrate on a limited field of stimuli, there is a great inner clarity; awareness is logically coherent and purposeful. This is the ordered, negentropic state of consciousness we have called flow. (Csikszentmihalyi *et al*., 1992, 34)

Because it is important that the music to be learned is not too easy or difficult, a good strategy is to use tailor-made arrangements for orchestras, especially when the students' skills differ largely from each other. As Csikszentmihalyi (1981) comments: "Experiences connected with playing can become rewarding as such if one's skills are matched with the challenges of the action". Similarly, Moneta

et al. (1996, 1999) had found that the imbalance of challenge and skills is associated with a reduction in concentration and involvement especially in the school context. Furthermore, Byrne *et al*. (2000) point out that it is essential that in group lessons the teachers ensure that the students and their development are "valued within an environment using collaboration and peer learning" (Byrne *et al*., 2000). The students themselves should also value their own playing if they feel that the music matches their skills, the challenges are interesting and motivating and not impossible to overcome.

Learning music in groups and orchestras can arouse feelings of stress; students may wonder if they can play correctly, what the teacher and the other players think about their playing? Nevertheless, not highlighting the mistakes during rehearsals and careful preparation leads to self-confidence on the stage. Under optimal learning conditions, students enjoy working hard; they can even tolerate extreme danger and stress. Further, "self-confidence and trusting in one`s own musical capacity helps in being creative during engagement in music and in this optimal condition, students enjoy working hard" (Csikszentmihalyi *et al*, 1989; Coulson *et al*., 2013).

The *Playback Orchestra* method is learning to play from "within" the music: learning is based on understanding the music: the style, atmosphere and message. In a way it is an intuitive, non-verbal music-learning method with supporting auditory elements and a flow-like learning strategy; the playing continues and is not stopped when minor mistakes occur (although it is important that the difficult parts are studied carefully afterwards: repeating mistakes is learning to make mistakes). There is instant feedback to check for correct playing during the practising, because an individual's playing can be compared to the playback.

By using the audio element for learning in addition to sight-reading, it could be established as a basis for a more cognitive learning strategy than using exclusively the traditional methods. When *playing* in good style the players learn to *play* in good style; in other words, they learn playing by playing. The method gives a basis for learning to play new music pieces well and gives orchestra playing attitudes and competences that are based on the process-like learning strategy. A positive style and environment in music learning and making creates strong motivation making the players alert and hard-working when practising. The students learn to be creative and develop whole personalities as musicians by using their whole capacity when both learning and performing music. Their musical expressions will allow them to participate in music as art.

4.4 A new blended music education environment: a mixture of supervised and unsupervised education

The principal aim of this thesis is to create a learning environment which includes *both* the best tools, methods and procedures of traditional face-to-face teaching *and* the advantages of recent music technology to benefit orchestra and play-together learning in a way that creates a good basis for motivated practising at home. It is hoped that this method will also provide a rich palette of educational tools for teaching and learning in classroom. This kind of learning environment is a mixture of supervised face-to-face learning in the classroom and unsupervised learning with the computer assisted *Playback Orchestra* method at home or outside the classroom. This new, larger learning environment can be considered *blended learning*.

The idea of creating new methods and materials arose from experiences when teaching orchestras and playing together groups in music schools. Joining the ideas of the extensive curriculum in music (see the Finnish National Board of Education, 2002) orchestras should have larger repertoires in varying styles. Accordingly, it was found to be necessary to create new material for the orchestras, music that varied in style and was tailored to the taste and skill level of a particular ensemble. It was thought essential that all parts of a string orchestra are idiomatic; in other words, it was considered natural for the left and right-hand technique. Further, if possible, the accompanying parts should have melodic contour or interesting rhythmic ideas and always nice pedagogic elements. Some of the orchestra etudes and arrangements made by the author of this thesis can be found in *Score Exchange*.

An important issue concerning orchestra and play-together education is motivation for participating of the students and families, and for home practising (see Vartiainen, 1995). Because in most music schools orchestra or chamber music regular rehearsals is supervised by a teacher or a conductor and usually run only once a week, it is crucial that the students practise their parts at home in addition to the time they have for practising in face-to-face rehearsals. How could the education system add motivation and joy for home practising? Are there any tools for the parents to tell the students whether they practise their scores correctly? How can the families be connected to the wonderful world of playing together music if they do not have an opportunity to be present at the rehearsals? Are there any new views for widening the orchestra and play-together learning environment outside the classroom of music schools. Are there any new tools available granted by ICT to support home practising? Using technology in string instrument and orchestra teaching does not seem to be the most natural choice for education. What, if any, would be the benefits in such unification; furthermore, would there be losses, and what might they be?

In order to answer these questions and explore the method, the author of this thesis has successfully used the *Playback Orchestra* method in orchestra and chamber music teaching since 2001: the repertoires of the string orchestras grew much larger, the atmosphere in both rehearsals and concerts was better than before. The students have reported that it is easy to determine whether they play right or wrong at home by comparing their playing to the playback. As the player gets to know the pieces of music thoroughly, his or her self-esteem and courage in the playing situation becomes stronger; the player can go with the flow without being afraid of mistakes. The results of this recent research are compatible with the guidelines set by the *extensive curriculum of music education, The contents of the basic examinations and bases for evaluation in violin basic education* (see Finnish National Board of Education, 2002; The Association of Finnish Music Schools, 2005) and the new curricula of some music institutes (see The curriculum of the Conservatory of Kuopio, 2014).

The learning environment connected with the *Playback Orchestra* method is broader than the traditional music teaching situation: it has an element of unsupervised, technology-based informal and self-directive learning style in the home practising phases, but the learning process as a whole is regularly supervised by the orchestra and the instrument teacher. The teacher provides or prepares the scores and possibly the audio material that is appropriate for the capacity of the players and also gives instructions concerning the home practising. Figure 19 describes the proportions of face-to-face teaching in instrument lessons and orchestra rehearsals, the use of the technology-based *Playback Orchestra* method together with the teacher in classroom or orchestra rehearsals and using the *Playback Orchestra* method in home practising. The blue areas describe supervised teaching in the classroom and the green area shows unsupervised learning at home.

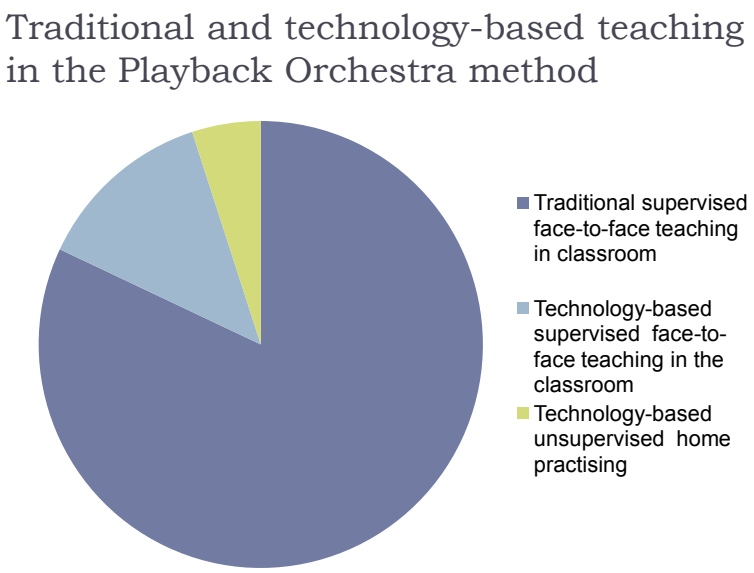

Figure 19. *Blended* play-together learning environment used in *Playback Orchestra* method. The approximate proportions of supervised and unsupervised, technology-based and traditional methods

According to general practice in traditional play-together rehearsals, when starting to learn a new piece of music in orchestra rehearsal the score is usually played *prima vista* ("as it comes") at first. This is a very important phase in orchestra education. Through *prima vista* playing students learn to orient to the conductor, read scores and play-together with the other players at the same time. After the *prima vista* playing, the conductor focuses on certain technical or musical details of the score or the parts and gives information of the playing style and how to practise the scores at home**.** As soon as the players reach an acceptable level on score reading and flexibility in the play-together situation and have learned the routines of the orchestra playing environment (see Finnish National Board of Education, 2002; the curriculum of The curriculum of the Conservatory of Kuopio, 2014), learning new music will progress naturally in the traditional style of education.

Nevertheless, the tool palette for orchestra rehearsals in the blended learning environment, which includes the *Playback Orchestra* method is larger: the audio of the music can be listened either before or after the *prima vista* playing. If the learning situation begins with listening to the audio before playing, the students can hear the whole orchestra and read their printed scores simultaneously from the audio. Before, or during, listening to the playback, the teacher tells the critical points: solos, articulation, bowing style and dynamics during the listening period. After that, if the power features of the speakers used is strong enough,

the orchestra may play along with the playback as a *prima vista* playing as well, thus taking a "music shower" metaphorically speaking. When playing along the players can hear their own part in the playback, they catch and drop and catch the music again (compare Ruismäki *et al.,* 2013, 7). This kind of procedure strengthens the flow-like learning strategy which is a natural part in a traditional orchestra learning situation, too: to hold the music and go on playing after dropping. This learning style strengthens the students' flexibility in play-together situations (see the guidelines in The curriculum of the Conservatory of Kuopio, 2014; Juntunen *et al*., 2013).

According to the principles of traditional play-together education, the students are supposed to practise their printed scores at home following the information they received at the rehearsal. When using the *Playback Orchestra* method, the students have a kind of virtual orchestra rehearsal available outside the classroom. In the words of Winn *et al.* (1992), they have a virtual reality that allows active participation, a rather coherent virtual "space" similar to that mentioned in Harper *et al*. (2000). The students can practise with a virtual orchestra at home whenever they want to play their scores: they hear the whole orchestra and their own part from the audio and they can match their own playing to the audio and decide immediately whether or not they play correctly. According to the research, immediate feedback on one's playing is crucial in music learning (Csiksentmihalyi, 1992; Huanhuan, 2010; Juntunen, 2011). Depending on the devices available at home, the students can listen to the audios from their computers, mobile devices, iPads, or even CD recorders. Whichever the device is, good speakers are needed in practice situations.

In the audio used as a background support, there is a short *intro,* usually four bars, so that the player knows the tempo and when to begin. The instrumentation of the playback has been chosen carefully: the sound of string instruments is used only after a strict deliberation, because the aim of the playback is not to teach the quite machine-like string sound of the programme to the players. Usually guitar or keyboards are chosen as instruments; the string instrument *pizzicato* may also be appropriate. The crucial feature in the background audio is that the contents of the music, especially harmony and rhythms, can be heard. Furthermore, the ongoing pulse being heard in the audio strengthen the timing of play movements (see Juntunen *et al*., 2013; Schellenberg *et al*., 1985, 207–217) and arouse the feeling of "playing together".

In conclusion, this study describes how a technology-based element, the *Playback Orchestra* method, was added to traditional face-to-face classroom teaching to be used during both lessons and home practice. The method supports aural based learning by giving an auditory model of the music to be learned. In the learning style a flow-like strategy is emphasized: the *Playback Orchestra* method is based on learning to play by playing along. As the results from testing the method showed, students learned essential features, to understand the con-

tents of the music better with the support of the audio component than without it. As a result, the students using audio background learned faster and more accurately on the basis of anticipation than those practising without the audio support. The new, larger blended learning environment seems to be appropriate in teaching play-together for first and second grade string instrument students in music school.

5 Conclusions

In this recent doctoral thesis are introduced some suggestions for a learning environment in which computer-based methods are added to traditional classroom teaching in music school. The technology-based element, the *Playback Orchestra* method*,* is aimed at supporting orchestra and play-together education for first and second grade string instrument students in music school. As far as I know, the use of notation programme playback as an educational tool in orchestra teaching is unique, at least in Finland, perhaps even in the world. The name of the method, *Playback Orchestra*, indicates using the playback of notation programmes in orchestra teaching, but as an auditory element other kinds of music technology can be used, such as Play-along CDs and other backing tracks. Nevertheless, using notation programmes is a good package of tools for an orchestra teacher who makes arrangements and pedagogical compositions in teaching: the score can be checked by simply listening to the full score and corrections made quickly and confidently. The scores can be sent via email to the students to be listened to, printed and played along with the iPads or computers at home. The prints are clean and easy to read; in addition, pictures can also be easily added to the scores, which is enjoyable for the students. Since using the method from the year 2001, I have found it effective in supporting learning musicianship skills and enhancing motivation in music studies (compare Figure 5).

In the new blended learning environment the accessibility of educational materials has improved: the scores of the newest arrangements can be bought, downloaded and printed at home, the recordings of different interpretations of the music to be learned can be evaluated and listened to from *Spotify,* and backing tracks from the Internet are easy to find and use to support practising. By browsing the material on the Internet, one can save money and time because it is not necessary to travel to a music shop. Further, because the teachers can send the scores and the audios for students via email, the students save time and money for travel expenses. The virtual play-together situations with the playback reduce the number of rehearsals needed for an occasional performance. This is a real advantage in a region where long distances separate the students from the music schools and the teachers.

In the spirit of Flipped Classroom, the face-to-face lessons can be used effectively for deepening the subject, because they have been pre-learned with the virtual play-together situations before the lesson. When students do not have to concentrate on sight-reading, the rehearsals can be used to create more refined details within the style, exercises for better intonation, coherence of bowing styles, even stage behaviour and appearance.

The learning strategy of the *Playback Orchestra* method used in the new *blended learning environment* supports a flow-like learning strategy that involves "letting go" with the flow of music. In a way, learning with the playback is learning to play by playing, playing first and correcting errors afterwards (see Cahill-Clark, 2013). According to research (Hallam, 1997; Clark, 2008), this strategy has been found to be a higher level practice strategy compared to stopping on every mistake. This learning style emphasizes listening to the environment, whether it is the playback or other players. It is an *orchestra-like* learning situation made possible at home and supports learning flexibility, which is one of the most important skills in play-together situations.

The style of active doing, playing to learn to play, seems to fit especially well for some boys and lively students who like "hands on" activities. It has also appeared to be appropriate for students who are a bit slow or clumsy and need encouragement: they have commented that when they have an auditory model of the music, an opportunity for repeated trials at their own time and pace at home, they feel comfortable playing music. Thus, they are prepared to face the obstacles in the social situation in the group lessons. Further, an intimate and close knowledge of the composition to be performed on the basis of hearing the full score also seems to help the musician to feel comfortable and safe enough to overcome stage fright

The technology-based component, the *Playback Orchestra* method, was tested in a quasi-experimental study design in which two professional violin teachers evaluated from video the playing before and after a practice period by scoring and the data was analysed with SPSS 22 and general and mixed linear models. The results showed that the string instrument students learned the essential features of the music better with the audio support, *playback* than without it. Those features were in a way on a higher level of understanding the music than knowing the notes: the atmosphere and style of the music contributed to using expressive play movements, concerning especially the body and bow, which were in harmony with the musical content. The clear and expressive play movements of the lead player led to clear and informative communicating of the co-players and this feature of playing could be easily noticed in the videos by the evaluators. In the study concerning improvisation the role of the auditory imagination was emphasized: the musical tale narrated by harmony, changes of key and playing style, and dynamics, inspired to improvisation performances for instance with *continue intensively* to tell a "story" in a fluent and coherent style.

Accordingly, part of the results showed differences between study groups (*playback* and *no-playback* group) in highly significant numbers in favour of the *playback group* concerning *understanding the general view and style and atmosphere* of the music. When testing first-grade students on learning a simple melody (Appendix 1 and 2) which was the leader's score of a chamber music composition, it was found that in the compound variable *communication* sig-

nificance of the result in favour of playback learning was very clear (p=.003). The left-hand technique seemed not to benefit from the audio support, but the influence of hearing the full score as a background generated "good technique of singing bow" (Table 7, v9, p=.005) when learning a film melody better in the *playback group* of second-grade students.

These findings mirror the guidelines for violin education (see The Association of Finnish Music Schools: The contents of the examinations and bases for evaluation in violin basic education, 2005) and follow the spirit of the extensive curriculum of music (Finnish National Board of Education). The aural basis of playback learning seems to support playing skills that are stated to be central in learning to play violin: finding a natural style of playing, being able to create the character and atmosphere of the music, to create good sound, intonation, articulation, phrasing and dynamics and perceive simple musical constructions. The aural emphasis and flow-like learning strategy of the *Playback Orchestra* method are also in line with the notion that students in the first stage should learn to play by ear and by sight (see The Association of Finnish Music Schools: The contents of the examinations and bases for evaluation in violin basic education, 2005). The *Playback Orchestra* method seems also to support the students' creativity in interpretation: as the students learn the whole piece of music from backing tracks or other audio recordings, they can create their own interpretation on the basis of hearing the harmonies and other contents, and not to lean only on the teachers' conceptions (see, Nielsen, 2006, 9; Mills *et al.*, 2003, 9; Nerland, 2007, 409).

There seem not to be any theories in research literature on which to base deeper considerations on the nature of learning in the aural-based *Playback Orchestra* learning method. The recent study should be considered as pilot research, possibly showing the way to more exact formulations of research questions and testing with much larger study groups. However, a metaphorical model of learning was made to describe the processes involved, a *gearwheel model*. The model suggests that the crucial factor in the auditory-based learning in the *Playback Orchestra* method is *understanding the contents of the music* by hearing. Understanding the music means figuring out the style and atmosphere, genre and harmonic relationships and perceiving the musical tensions and resolutions that are crucial in building the musical structures. These actions in turn lead the student to play movements in harmony with the music and with the timing suggested by the pulse of the playback. Applying the *gearwheel model* further, it can be seen that the activities connected to playing in good style, pulse and rhythm are stored in the memory mechanisms that provide support in enhancing the appropriate future hearing, reading and playing actions.

It seems that hearing the music may generate some kind of image, which helps students to anticipate future hearing, reading and playing. Anticipation, in turn, leads to learning quickly, accurately and confidently; the errors are avoided

in advance. Further, there was a notion of improvisation in the guidelines for music education: "in addition to learning new compositions from printed scores, the violin students in the first and second grade should be encouraged to improvise" (The Association of Finnish Music Schools, 2005). This recent research seems to show that using audio background when learning to play a piece of music benefits improvisation skills: it was found that learning a musical tale with the support of an audio supported improvisation performance more than learning the tale without the playback.

Concerning the learning environment introduced in this thesis from a broader view, it seems that it follows the spirit and lines of the guidelines of extensive curriculum in music stating that "the learning environment has a crucial role and the teacher has an important role in *developing the learning environment*". Based on the experience of using the method for fifteen years the learning environment seems to be "open, encouraging and positive, to give experiences of success and strengthen self-confidence", as outlined in Finnish National Board of Education (2004). The clear results from testing the method support learning the play-together skills outlined in The curriculum of the Conservatory of Kuopio for the basic stages of music: *the student should hear and recognize musical phenomena and react to them in a group in harmony with the style of the music* (2014). Further, the author of this thesis has answered the request that orchestras should have repertoires in varying styles and challenges and that the scores to be learned should not be too easy or difficult: using tailor-made material, arrangements and compositions (see Score Exchange), the skills of all players match with the technical and musical challenges of the scores, accordingly the students can play relaxed and feel the experience of success both in the face-to-face lessons and in the concerts.

In music school education the blended learning environment in which the *Playback Orchestra* method has been included is generally traditional classroom teaching. The teaching system can be considered to belong to the category "blended learning", because it is supervised in the classroom situation and controlled by teacher also during the student-centred, self-directed moments of practising outside the classroom. The material for learning is produced and the procedures are informed carefully by the teacher. The equipment in the blended learning environment consists of traditional tools: instruments, stands and a piano, which has an added iPad and speaker for accompaniment. Most of the time the lesson is spent with traditional procedures concerning instrument teaching and about five to ten minutes (from 45-minute lessons) is used for practising orchestra parts with the iPad providing background music (see Figure 19), much like a "virtual orchestra rehearsal" in the classroom. In the neighbouring classroom, the students can practise with the computers self-directed on their own time and pace without the teacher. The playback is also sent via email to the students, or they get them on CD for home practising. This procedure is in line

with the *extensive curriculum* guidelines that state that "the learning environment should make possible for students to work independently on their own" (Finnish National Board of Education, 2002).

A more philosophical view and historical perspective on learning shows that traditional Western music education has concentrated on learning from knowledge to action; the information is given before learning the deeper contents of it, "learning by lecturing". The teaching strategy can be described as educating students' musical skills with methods in which verbal characterization of musical processes and styles is used; the teacher takes one topic after another, mosaic fragments instead of larger entities, inanimate bits of musical material instead of flowing and pulsating music.

This recent pedagogical study continues the discussion on learning music in the light of brain research (see for instance Seppänen *et al.,* 2007; Zvyagintsev *et al*., 2013; Janata, 2001; Meyer *et al*., 2007) and gives a few suggestions for new views and methods with which to create broader and deeper music education environments by which the students can use and develop their whole personality and the capacities of both brain hemispheres. The Western way of thinking and educating is based on rational, analytical and verbal tools, which in brain research have been figured to be features of the left-brain hemisphere. The right hemisphere is thought to be responsible for non-verbal, holistically synthesized and intuitive actions, similar to an Eastern way of thinking. The left hemisphere operates successively, taking one detail at a time, whereas the right hemisphere acts simultaneously, taking in all details at once. The left hemisphere is a logical, rational area, while the right is an area that is emotional, creative and artistic.

Based on the results from the study on the impact of *Playback Orchestra* method on learning musicianship skills and based on the experience of using the method from about the year 2001 it seems to me that the traditional education environment could with good reason be added with aural learning strategies and broadened with technological elements like the playback of notation programmes and using the Internet. Accordingly, it seems reasonable to suggest the blended learning environment described in this thesis to be used in orchestra and play-together education of first and second grade orchestra students, but under careful and insightful control of teachers who know the principles of traditional education, have the capacity to use technology and have a positive attitude to creating new methods, in whichever domain they can be found. It is also easy to agree with Sloboda who states that, "Computer music often sounds inhuman" (Sloboda, 1998, 6). Keeping this aspect in mind, the features of the audios which are used, and educational targets to which they are applied must be carefully chosen so that they support and do not disturb the learning processes.

A crucial aim of education should be that the students are afforded the possibility to use and develop all of their capacities and whole personality, and through this to benefit both brain hemispheres. The journey is more important

than the ready-made musical product; by acting and learning like a musician, the students have the potential to become great musicians and personalities. As musicians, they can feel free to create and interpret music in a personal, individual way, safe and relaxed in music making with others; they can develop self-esteem in sharing music with others, co-musicians and the audience in an atmosphere of insight and joy.

5.1 Validity, reliability and ethical issues of the research

The reliability and validity of the research are important parts of credibility and authenticity of the whole research study. The validity of the research implies that the measuring tool measures the particular phenomenon at which it is aimed. In that case the researcher has succeeded in formulating the theoretical background and the ideological bases behind the research, to the questions asked about the phenomenon, which are used as the measuring tool (Vilkka, 2007). If the researcher has not lost her/his way on a conceptual level and there are no systematic errors, the research is valid. (Uusitalo, 2001; Heikkilä, 2004, 29, 185–186; Valli 2001, 100.) When estimating the validity of this recent research and the impact of the *Playback Orchestra* learning and teaching method on orchestra and play-together education of first and second grade string instrument students of music school, we consider first the formulating of the questions asked of the estimators: on which basis have the questions been chosen, do the researcher and the estimators understand the questions in the same way, and is the scaling style of the measuring tool appropriate concerning the learning outcomes; is it accurate enough to also measure minor changes in play performances?

Before beginning the testing, the design of the study was configured carefully. The quantitative approach using a quasi-experimental study design was chosen because it is a common practice to evaluate playing performances with numerical estimation in music schools; accordingly, the scaling is known to the music school violin teachers who were the estimators in the research. In other words, the music education community has agreed that this style of evaluation is appropriate. The scaling style is also approved in *the contents of the examinations and bases for evaluation in violin basic education (*see The Association of Finnish Music Schools, 2005.); accordingly, the measurement tool can be considered to be valid in the field.

The scaling style in music school uses only full numbers (1-5), but in this recent research pluses and minuses were added to get a more nuanced estimation (i.e., accuracy) on the area which is mostly used in evaluating the play exams in music schools. Accordingly, the scaling style 2, 2+, 3-, 3, 3+, 4-, 4, 4+, 5-, 5 was used and also approved to be appropriate by the two estimators of the study. For analysis the scores were recorded as 1-10. The researcher also gave some illustrative information on the meaning of the particular questions (see Appendices

11-13). The evaluators were also informed to place the students' performances in a "rank order" based on their performance as a whole. This operation was aimed at getting evaluations of the performances of the students that were put into perspective with another, which was aimed at limiting the inaccuracy of the measuring tool (see Vilkka, 2007, 150). This is in line with the usual practice in music schools: in music school exams the discussion of numerical estimation of the performances often begins with evaluating the performance as a whole, which gives perspective for further, more detailed evaluations.

The second reason for using the quasi-experimental study design (in addition to the possibility of numerical evaluation) was that with advanced technology in using video, it is possible and easy to use video recorded performances in evaluation. All the testing situations were video recorded, and the estimators received the first and last testing situation to be evaluated on their own time and at their own pace. The estimators informed the researcher that this procedure was acceptable to them and they also said that they understood what was meant in the questions. In conclusion, the measuring tool can be considered to be valid. The tested students also reported that video recording did not disturb or distress them. In fact they later wanted to see their own video clips from the test situations.

Concerning the basis for choosing and formulating the questions for the estimators, three criteria were used. First, they should mirror the guidelines of the *contents of the examinations and bases for evaluation in violin basic education (*see The Association of Finnish Music Schools, 2005) concerning the features and skills being taught to string instrument education of first and second grade students and the guidelines on the skills to be learned in playing together (The curriculum of the Conservatory of Kuopio, 2014). Second, two professional string instrument teachers were asked about the characteristic features and playing challenges of the pieces of music used in the tests. Accordingly, opinions of professional teachers were used when creating the questions for the evaluators. The third basis for the questions was a bit more philosophical: what happens in the minds of music students in learning a new piece of music? Does hearing the music lead to learning processes in which understanding the music (see Sloboda, 1998) inspires the players for faster learning and to producing better sound than when learning by sight-reading? Do musicianship skills, flexibility in play-together situations and musical communication improve rapidly in a learning situation which includes auditory background to generate a deeper knowledge of the music? Finally, the main philosophical, conceptual question behind all of these questions: could there be a model of the music to be learned, a kind of schema that exists when hearing the whole music, a "full score in sound"? Based on these considerations, the questions were raised and the estimators commented that there were acceptable. The questions in the study are, as far as I understand,

comprehensive and related to the field in this research; they cover the research area chosen for this research.

According to Briggs (2008), to determine the magnitude of the effect of an education programme on student outcomes, a randomized, controlled experiment is best. Nevertheless, contrary to the experimental ideal that a good study is a "noiseless" one, a study can also be regarded as "ecologically valid" if it captures teachers' everyday experiences which are being bombarded by numerous factors (Black *et al*., 1998; Valli *et al*., 2007). Ideally, a good study should be strong in that the same result of a given study can be observed in other situations; however, in real educational research this objective is never completely met (Campbell *et al.,* 1963, 5).

In this recent research both qualitative and quantitative methods of analysis have been used; this approach is widely used in the social sciences (Cohen *et al.*, 2007 b, 141–144; Metsämuuronen, 2006, 454; Johnson *et al*., 2007). It seems obvious that the questions concerning education cannot be addressed convincingly without also taking a qualitative approach (c.f., Eisenhart, 2005; Maxwell, 2004); accordingly, the qualitative approach was applied in the recent study in connection with improvisation. A qualitative view on research was a reasonable choice, because in that delicate aspect of learning music, improvisation, the differences between students appeared to be very large, presumably due to differences in musical capacity and features (see Juntunen *et al*., 2015, 8).

Whether causal inferences are in some sense scientifically valid in the educational research, has been largely debated in the educational research community (Eisenhart *et al.*, 2003; Raudenbush, 2005; Shavelson *et al.,* 2003). According to Briggs (2008), in attempting to understand at a finer level how a cause produces an effect in educational research, we must consider that there are mediating and intervening factors involved, and there will be occasions when the interactions with them make any single number intended as an estimate of an aggregate causal effect rather difficult to interpret. Briggs (2008) uses the concept of *Potentially Positive Effects* of the treatment as a reasonable expression in the recent field of research. In a quite complicated expression, Briggs (2008) states that "evidence of a positive effect could be inferred if no overriding contrary results have been found, or, alternatively, at least one study showing a statistically significant or substantively important positive effect and *no* studies showing statistically significant or substantively important negative effects and fewer or the same number of studies showing indeterminate effects than showing statistically significant or substantively important positive effects". In this recent research several statistically significant results favouring the test group (*playback group*) were found and no significant results favouring the control group (*no-playback group*) were found. (See Tables 2-7.) Concluding from the formulation of Briggs above, the effects of treatment (playback support) in this

recent research can be considered a *Potentially Positive Effect* on learning to play music.

The second requirement to be met for the research to be credible, in addition to validity, is the reliability of the research. Reliability implies that the research results are constant from one measuring situation to the other; in other words, it means repeatability of the research. In a very strict sense the research is reliable and accurate if repeated measuring gives exactly the same result regardless of the particular researchers involved (Vilkka 2005, 161; Hirsjärvi *et al*., 2005, 216; Hirsjärvi *et al*., 2002, 213). In strict sense, the results, according to Heikkilä (2004), should not be generalized outside the particular research. In other words, the results should be restricted to a particular place and time (Heikkilä 2004, 30, 187). Concerning the recent research, the repeatability of the research is accomplished by using video recordings; accordingly, the evaluation results can be double-checked by redoing the video-based evaluation of the video recorded play performances. In the "real world" these re-evaluations likely will not give exactly the same scorings as in this recent research, but on the basis of examining the results widely, it could be predicted that the redoing should give the same *outlines* of results as described in the results section of this thesis.

Concerning Heikkilä's (2004, 30, 187) statement about generalizing the results, we should also take into account the goals of this kind of research. If the results are aimed at basing future decisions on learning environments, the results should be generalized in the measure that it is scientifically justified. According to Cronbach *et al*. (1982): "If the study lacks generalizability, then the so-called internally valid causal effect [reliability of the research] is useless to decision makers". Cronbach *et al*. (1982); Cronbach (1988) argued further that

> ...for the results of [an educational] program evaluation to be relevant to a broader educational context, it becomes necessary to extrapolate a causal inference beyond the specific students, school settings, program implementations, and measurement outcomes internal to the study. If such an extrapolation is not warranted, then it would make little difference whether an observed causal effect was internally valid [reliable], because the evaluation would lack relevance for subsequent decision makers. (Cronbach *et al*., 1982; see also Yu *et al*., 2010)

Discussing further, although educational policy should be based on empirical evidence, an education programme should in some limited sense, have been "proven to work" in a real-life situation (see Pittler *et al.,* 1999). In fact, the superintendent of a school will have questions not only about what *has* worked, but also what *will* work, when and where will a given programme work, for whom will it work, and under what conditions will it work best (Briggs, 2008). In conclusion, mirroring the words of Yu *et al*. (2010), adopting experimentation in education should not imply advocating a position incompatible with tradi-

tional wisdom. Rather, experimentation may be seen as a process of refining or enhancing this wisdom. Therefore, cumulative wisdom and scientific findings need not be opposing forces (Yu *et al*., 2010).

In summary, the results of the research need to be generalized for the purpose of influencing the decisions concerning educational strategies, but the generalization must be based on the results of qualitative research, randomized experiments or other sound conditions for scientific testing. In addition to those requirements, the programmes intended to improve learning should have a history of success. In this recent research, there is a long history of using the method to be tested: it has been successfully used by the researcher since 2001(see Articles III-VI). The principal aim of the testing is to give scientific support to the method studied in this research with the aim of providing a basis for further considerations of decision makers on music educational strategies and learning environments.

The conclusions made based on the research results have to be reasonable, appropriate and useful (Nummenmaa *et al*., 1997, 203). In case of incorrect conclusions the researchers "find" non-existent relationships or principles, or do not see the existing ones, or raise the wrong questions (see, i.e., Kirk *et al.* 1986, 29-30). Lincoln *et al*. (1985, 301) mention *the engagement of the researcher to the field* as a factor that increases reliability, which in this study is assured because the researcher has a music education background as a professional violin and orchestra teacher in music school. Similarly, Metsämuuronen (2006) notes that the knowledge about different characteristics of the surroundings in the music school is especially important in order to comprehend the particular educational reality (Metsämuuronen, 2006).

The reliability of research study is in the first place connected with measuring and accuracy, which means limiting errors. The following questions can be raised: is the sample used representative of the particular part of population in question? In other words, is the size of the sample large enough and the compound of the sample appropriate? Are there losses of scaling figures? Are there errors of measuring the particular subject matter in the research inclusively? (See, i.e., Vilkka, 2007, 150). Concerning this recent research, the size of the sample is small (the first-grade students N=10, the second-grade students N=4). Although the study groups were chosen randomly, the generalizability of the results is limited; further research with larger study groups should be made. The study can be considered as a pilot research project for further testing and research with more precise research questions and larger study groups. Nevertheless, some tendencies can be observed and they suggest ideas for further research in the field. In addition, the study groups are representative of the particular part of population which the research concerns: they are all string instrument and play-together students in a music school (see Appendices 6 and 7). All of the tested students were familiar with the *Playback Orchestra* method from using it

and have been supervised by the researcher for many years; accordingly, the study groups were homogenous in terms of their educational background and preparation for music studies.

In the recent research, there inevitably are factors that may jeopardize the research. Yu *et al*. (2010) mention a few of them: a pre-test might increase or decrease a subject's sensitivity or responsiveness to the experimental variable. Indeed, the effect of a pre-test to subsequent tests has been empirically substantiated (Putnam *et al.,* 1982; Lana, 1959). A most notorious factor concerns the recent research: as multiple treatments are given to the same subjects, it is difficult to control for the effects of prior treatments. In addition, the technology skills of the evaluators, students and the families may be seen as a reliability issue in this research and thesis. Accordingly, for home practice purposes the audios with different tempos were delivered on CDs, so that in the test group all participants had the same level of familiarity/difficulty in using the devices. One of the two estimators wanted to write her evaluation on paper; the other sent it as a PDF by email.

Nevertheless, theorists such as Cronbach (1988), Messick (1989), and Shepard (1993) have emphasized the notion that evaluating and creating tests should be viewed as an ongoing process of scientific research. In addition, Kane's thesis (Kane, 2006) states that test validity is a matter of degree and depends on the clarity, coherence, and plausibility of any interpretive argument that links test scores to the decisions and inferences for which they are to be used. In this recent research, the data consisted of evaluation scores given by two professional violin teachers who estimated the playing before and after a practice period and the test and control group had different practice methods. Accordingly, the recent research was concerned with changes in playing skills over time and linear models were applied in statistical analyses. Traditionally, researchers use generalized linear models (GLM), such as analysis of variance (ANOVA) and analysis of covariance (ANCOVA), to examine changes in behaviour across time. However, these methods would estimate accurately only in a balanced repeated-measures design (e.g., equal group sizes, see Shek *et al.,* 2011). Unfortunately, this condition is difficult to meet in the kind of this recent research. The use of the traditional univariate and multivariate test statistics might increase Type I errors under the condition of an unbalanced repeated-measures design (Francis *et al*., 1991; Hox, 2010; Singer *et al.*, 2003). Longitudinal observations may not be truly independent because of repeated measurements of the same students; the data used for analysis will include data that are duplicated in a way that observations within the clustering unit are correlated, which will eventually result in biased standard errors (Shek *et al*., 2011). It is important to diagnose this problem, and figure out ways to deal with them (Hox, 2010; Barcikowski *et al*., 1981; Graves *et al.,* 2009). To solve these problems the analysis model used was a linear mixed model that can be used for repeated data involving a cate-

gorical and continuous covariate. Applications of mixed models are common in the social sciences, especially in research in education; it is regression analysis that takes into consideration the dependence of repeated measures and it was applied with a Bonferroni correction, which is employed to reduce Type I errors (i.e., rejecting Ho when Ho is true) when multiple tests or comparisons are conducted (Nakagava 2004).

In addition to the discussion on validity, reliability and generalisability of the research and the results, the ethical principles and the construction of report should also be taken into account. The ethical issues in educational and social research are important points of discussion, which are emphasized by several authors (Miller *et al*., 2012). In fact, as Cohen *et al*. (2007 a) recognize, ethical issues are posed at every stage in the research. It is proposed to create and use "an ethical code" of the researcher where such important factors as privacy, confidentiality, human dignity, honesty, attention and care are followed (Cohen *et al*., 2007 a, 51–77). In this research I acknowledged the possible existence of ethical problems and from the very beginning of planning the study tried to prevent the forthcoming troubles connected with ethical issues. I have aimed at behaving appreciatively towards the students and families, as well as the estimators as colleagues, in the same approach as when doing my professional work as a violin teacher.

Concerning the privacy of the tested students, I asked them and their families to give written permission for video recording the playing and using the videos for evaluation and also to be shown in closed conference situations (see Appendix 14). According to the policy of research principles in the field of sciences, the tested students are addressed anonymously by using player numbers (Appendices 6 and 7) in my reports and articles. However, according to Vilkka (2007), a crucially important issue in addition to those mentioned above is *how the researcher writes* about the participants in the research (see Vilkka, 2007, 164, see also Kuula, 2006, 64,108, 207). The researcher should avoid expressions that may lead the participants in the research to be viewed with dislike, aversion or hatred (Vilkka, 2007, 164; c.f., Kuula 2006, 62–63, 201, 205–206; Creswell, 2013, 67). It should also be noted that as a writer the researcher is not only representative of her/himself, but also the discipline of the institute and scientific community of which she/he is part (Kuula, 2006, 63). Concerning Articles I-VII and the recent research report, I have carefully tried to write in a style that follows the lines described above.

6 Discussion and future perspectives

Being a music teacher today is a fascinating adventure; the world is changing rapidly and consideration of the methods of teaching and learning environments is needed for professional work as educators. To what extent are the traditional methods and tools sufficient? Should I be open to the same kinds of issues but consider different resources and methods? Would that attitude give any positive additional results or only disturbance and loss of time? Would it lead to misleading goals, rather than genuine music learning? In addition to those considerations, students are very sensitive concerning the style and range of knowledge and skills of their teachers. Can I be accepted as a teacher?

I think that having music technology skills does not decrease the teacher's competence as a "traditional" teacher with the traditional views on what are, say, the performing traditions of classical Western music or good principles and practices in learning instrumental skills. As Ajero said (2011), we are fortunate to live in an era of technological achievements, and there are remarkable tools available to us as instructors. These tools can also be engaging and fun for students, enhancing the experience for all involved (Ajero, 2011). Nevertheless, as Bauer (2014) asserts, "Few music teachers use any kind of music technology", and continues: "this resistance to technological incorporation threatens the relevancy of the music classroom. By making baby steps into the technological world music educators can showcase music education's relevance" (Bauer, 2014). Giebelhausen (2015) takes part in the same discussion: "Technology in music can be a powerful tool", and recommends that teachers proceed step by step when exploring a new direction for their music teaching (Giebelhausen, 2015).

It took about ten years of work for me to take the "baby steps" when exploring and practising the appropriate use of the notation software. I started with writing because I wanted clean prints; after that I became interested in the usability of the playback in learning new scores. The latest finding is the iPad and its applications, especially AvidScorch, in sharing the scores and playbacks in the same package via email. Now I easily manage with all the devices and programmes needed. Using technology does not take extra time during the precious face-to-face lessons. I think the doors are open to new "rooms" for my teaching. Now the resources are much larger than before the time of using technology in teaching.

Still, I would like to share my experiences with my colleagues, but unfortunately it seems that they are not yet ready for these conversations and new perspectives. When asking Finnish string instrument teachers in an informal open

questionnaire by email about their use of music technology in teaching, they responded that *YouTube* was their most often used source for background information and performance model. Only three string teachers (out of forty respondents) reported using notation playback in orchestra teaching and one teacher as a solo accompaniment (Juntunen *et al*., 2011, 12; Juntunen, 2011, 8).

Advances in music technology have raised new questions about pedagogy, curriculum and ethics of education (see, for instance, Brown and Dillon, 2012; Burnard, 2007). Nevertheless, as Vainionpää (2006) states, new pedagogical practices and models of learning tend to be constructed around the new technology, though this should be carried out in the opposite direction: the research of education and learning should generate new views and theories upon which the new technology-based practices can be tested. In other words: when aiming at effective learning, technology can be used as a support (Vainionpää, 2006, 2). Ruippo (2015) states that teacher training brings out silent knowledge and produces innovations and the ideal situation should be that the teachers may teach by the methods they know best, but could have the *opportunity* (italics by Juntunen) to be acquainted with new pedagogical possibilities (Ruippo, 2015, 98, 100-101).

The crucial point in planning changes and enhancement to recent pedagogy is the experience of professional teachers. It is important to note that the knowledge of experienced professional teachers is a crucial basis for this discussion; accordingly, teachers' visions have been investigated to find images of ideal practice to enable a holistic understanding of teaching (Bates, 2011). Nevertheless, based on research, it seems that the attitudes of music teachers and other educators remained grounded in tradition and instrument-specific issues. When studying how different traditions influence education concerning how *to teach* instrument learning (Mills, 2002; Nielsen *et al.,* 2011), ear training and music theory (Blix, 2009; Ilomäki, 2011) in music academies, it has been found that visions of teachers concerning instrumental pedagogy are quite instrument-specific and the educators' reflective attitudes are mostly directed towards and stay within the instrument-specific teaching traditions. Thorgersen (2015, 11) states that

> It even seems that traditions limit the educators' visioning ability, thus it should be important to investigate how this limitation of visioning has implications for the preparation of teacher students for the multi-dimensional changing society in which they will perform their professional work. One risk can be that the traditions are conserved, which might build up frontiers towards some groups of potential pupils or youngsters who want to learn to play. (Thorgersen, 2015, 11)

Thorgersen even suggests some radical procedures: "One way of opening up the situation from a scientific angle could be to run action research studies where

pedagogy teachers are forced to make visions beyond the limits of the tradition and imagine new border-crossing arenas for the profession toward which to educate student music teachers" (Thorgersen, 2015, 11).

Inevitably pedagogy is changing. It is clear that any change in educational practices must begin with the teacher education institutions and their students. The future teachers will have to be capable of building rich learning environments filled with opportunities for authentic, project-based and collaborative tasks. Teachers should have access to technological and non-technological tools (Mishra *et al.*, 2013). To bring this about, teachers' pragmatic experience is essential (Daniel, 2004, 2006). As Odam has stated: "There is an urgent need for music teachers to become more computer literate, it no longer is acceptable to rely on the pupils knowing more than the teacher does" (Odam, 2000, 116). For students, *learning*, not the method, is crucial, and according to Ruippo (2015), the students' attitudes are basically positive towards web-based learning. However, there seem to be differences among students due to age in attitudes towards new methods. According to Nikula (2006), older students feel uneasy when they have to change their study routines, but the younger ones are curious about the new ways of learning; they began with an "open mind" (Nikula, 2006, 326).

It appears that educating teachers in the use of technology is a key component in almost every improvement plan for education and educational reform efforts (Thompson *et al*., 2003; Gupta *et al*., 2012; Latham *et al.,* 2012). In fact, teacher education institutions have an important role in modelling the integration of technology and student-centred pedagogies for their students (Ertmer *et al*., 2010) by making it possible for them to experience these alternative ways of learning and thinking (Gibson, 2005). Nevertheless, decisions concerning educational technology should be made on the basis of educational aims rather than using technology for its own sake (Laurillard, 2002; Latham *et al*., 2012). It is crucial that general theoretical perspectives about teaching and learning, which are central to all teaching, with or without ICT, should not be ignored (Sutherland *et al*., 2004) and teachers should understand in which ways technology can support and facilitate meaningful learning (Angeli *et al*., 2009; Ertmer *et al.,* 2010).

Taking part in the discussion on technology-based resources for education, Niinimäki *et al*. (2014, 133) noted that it is the task of professional teacher education to guide the students to benefit from different kinds of web-based environments and technologies in their professional work as teachers and to teach them to guide their own students in using technology-based tools and environments; they also need to pay attention to copyright, information security and data privacy (Niinimäki *et al*., 2014, 133). In addition, the technological and distance learning skills will be an advance for employment applicants (Nissi, 2010), a point which, according to Ruippo (2015) should be largely taken into account in

music teacher education. Nevertheless, in everyday educational work, preparing for web-based lessons takes time: keeping up the interaction, noticing the students and the technical conducting is more troublesome than in face-to-face teaching. Preparation routines are for the most part made before the lessons (Manninen, 2003, 27), but these efforts that require extra time are not rewarded with additional salary payments.

Being a violin and play-together teacher in a music school, I think that even if it takes much of my time without bringing me any money, that experimenting, arranging and composing are the key resources in teaching musicianship skills. I like to mirror Partti (2012) who states: "Encouraging students to compose their own music provides opportunities to promote an experimental attitude towards music rather than merely nurturing an ability to adopt existing musical values and practices by reproducing designated repertoires or instrumental combinations", and further: "making one's own music--composing--could and *should* be part of music education at every step of the way from school classrooms to conservatoires and teacher education" (Partti, 2012). Because music technology in particular allows easy access to musical collaboration among a wide range of music makers, recently it would technically be possible for music teachers and students together to learn through a *network* of expertise, shared practices and distributed knowledge (compare Minifiddlers in Ruokonen *et al*., 2013). This is in contrast with traditional educational settings, especially those within higher music education where the construction of a musical identity through learning is often a private process shared exclusively between the master and the novice (e.g., Hirvonen 2003; Huhtanen 2004).

The interaction between informal digital musicianship and formal music classroom should generate prolific views, attitudes and procedures in harmony with the values and meanings of both environments: musicianship skills based on firm formal education connected with wider views on creating new ways of learning, such as peer learning and learning from people other than teachers. Music education institutions should help students to bridge the gap between local and global learning environments, by actively looking for and developing practices that facilitate a natural continuum between different learning environments.

Matti Ruippo, a musician and educator, who has been in charge of developing web-based learning technologies especially by video conferencing techniques in Finland and worldwide, stated many years ago that ICT could both musically inspire young students and increase professional musicians' productivity. According to Ruippo (2003), the attitudes of teachers and students towards using the new technology have been positive in general and as soon as teaching organizations also become more aware of the possibilities and gain more experience, their appreciation of the potential use of music technology and distance learning will grow (Ruippo 2003, 25). Recently, in fact, the music

education environments are gradually becoming larger in music schools: there are ICT studios and technology courses running in many music schools. These activities allow both students and teachers to study music technology, such as notation programmes. Teachers using the notation programmes could have an active role in developing the notation programme playback to a more natural sound. It would also be important to afford appropriate devices, such as iPads for teachers in the music institutions. Inevitably, iPads will be music teaching tools that complement the traditional educational "apparatus" in the near future in instrument teaching.

According to extensive curriculum in music learning (National Board of Education, 2002), ICT and music technology can be optional instruction in music schools. Nevertheless, it is easy to agree with Kurki's ideas (Kurki 2005): much research on music education and the use of new technology is needed before new music education can develop. Kurki (2005) studied the pedagogical ways to use computers in music education, and he writes that new technology and globalisation sets new challenges and opportunities for music education while at the same time the basic contents of music education must be presented. Indeed, the rapid advancement of ICT gives ever-expanding tools for education in music schools, including distance lessons. According to Mäntyranta (2011), the possibility for distance learning can minimize the problems with the calendar and availability of classrooms: the teacher can give distance lessons at home and the most popular teachers can mediate their teaching to many districts at the same time (Mäntyranta, 2011).

The teacher's profession is changing and one of the best ways to evaluate and support the change is teacher education. Concerning higher levels of decision making in guiding lines of education, the Ministry of Education and Culture (2015) bases its decisions on the *Developing information society and education 2020* report (Finnish National Board of Education, 2010, 14). In the report the skills of teachers and teacher education have a crucial role. The vision for 2020 states that *schools and education institutes use face-to-face, distance and blended education environments in which the latest knowledge, new teaching methods and research are used effectively in education.* Further: *All students graduating as teachers have good basic skills for using daily recent ICT technology as a support and option for teaching and other kinds of instruction.* (Finnish National Board of Education, 2010, 14.) According to Ruippo (2015, 109), this information has been noticed in music teacher education, but it has not led to very strong action. In addition, in-practice education of music teachers is not systematic. The *Osaava* project (2010-2016) of the Finnish National Board of Education is a general project for schools and liberal adult education, but music courses are almost entirely absent. However, there is a need for an intensive project aiming at developing low latency videoconference systems, online communities of music and mobile applications for use in music teaching. Ruippo

(2015) also states that the same methods should be used as the teachers will use in their teaching: co-operative learning, technology-based learning, research-based learning and learning by doing; these methods can be easily used in play-together situations (Ruippo, 2015, 110).

Recently, crucial questions have been raised about who is responsible for offering time and tools for discussions and development projects. Is it the headmaster of each institution or the teachers themselves? I could suggest that it is everyone in the field of music education

Although the importance of music technology has (more or less) been noticed in music schools, there is next to no ICT pedagogy in teacher education; accordingly, the education policy varies between music institutions from no education at all to some pedagogy at institutions that are willing to invest in ICT skills. To advance in the situation, a recent pilot project has been run on creating guidelines for a model of music technology education as a subject in music schools. The report is now available on the Internet (TeknoDida, 2015). Nine music institutes took part in the pilot project in which student groups received courses periodically on a limited topic and teachers in learning educational tools based on music technology aimed at creating and benefiting pedagogical methods. The school headmasters received advice for acquisition of devices and programmes. As a result, it was considered important that there be at least one teacher to manage music technology skills, that the head of the school has figured the role of music technology as a part of music education and that the communication between the expert in music technology and the headmaster work well. According to the ideas of the report, the students should learn with music technology studies to work independently and use and develop musical and artistic skills by means of the programmes, software and devices used in music technology (TeknoDida, 2015). According to Ruippo (2015), professionals in both technology and education, in other words, pedagogic developers together with application innovators should work together when developing technology-based education.

In the Olympic Games saying goes: *altius, fortius, citius*. Human beings have made efforts to develop themselves in physical skills, endurance and abilities to vanquish their competitors. Nowadays the crucial saying could be *faster*, *smaller*, *and more powerful* and signify the properties of information transmission, technological devices and their influence on human life and learning. It will be interesting to follow this process to see if the music schools can profit from the guidelines for a model of music technology education described above, and in which way. Is there going to be change in high school teacher education to revise the views of teachers and headmasters of music schools concerning learning environments and attitudes toward new methods and procedures?

There is a fascination in music. Creating the space for the rich musical experience should be the principal aim and teaching guide for a music teacher.

Musically talented students are very sensitive; they do not want to disturb the musical moments with rough sounds and poorly prepared musical performances; they want to learn to be good musicians. Being a music teacher is an opportunity: teachers can engage themselves and all their capacities to work with talented children who share an interest in music. Music school teachers are quite free to choose the methods and tools in a wide variety of fine traditional ways and new tools afforded by technology. Life is changing and moving at the speed of change is a great *educational* challenge; it is up to educators to take this opportunity to challenge their teaching methods and the entire educational environment. I took and welcomed the challenge as an opportunity to give violin and, especially, orchestra teaching a large scale of tools to be chosen in various situations and for different kinds of learners. The speed of change in life goes together well with me as an experienced music educator and as a music loving person.

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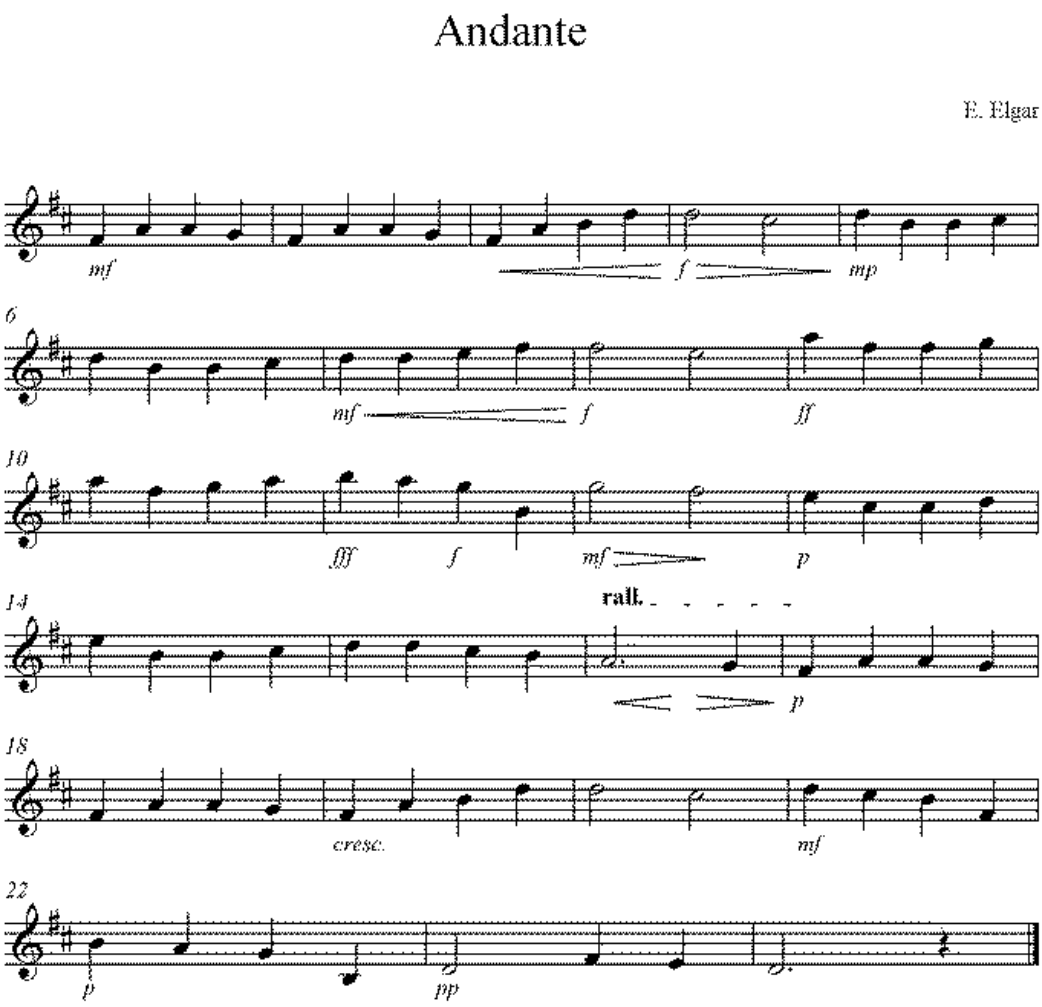
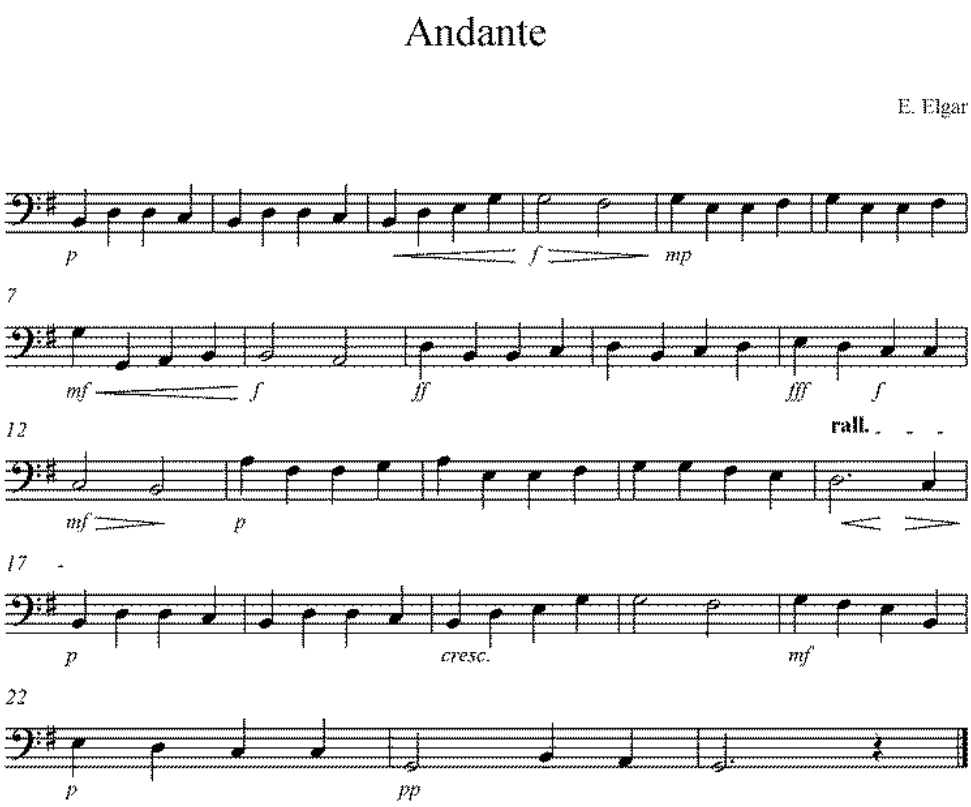
Appendices

Appendix 1. *Andante* by Edward Elgar. Violin score

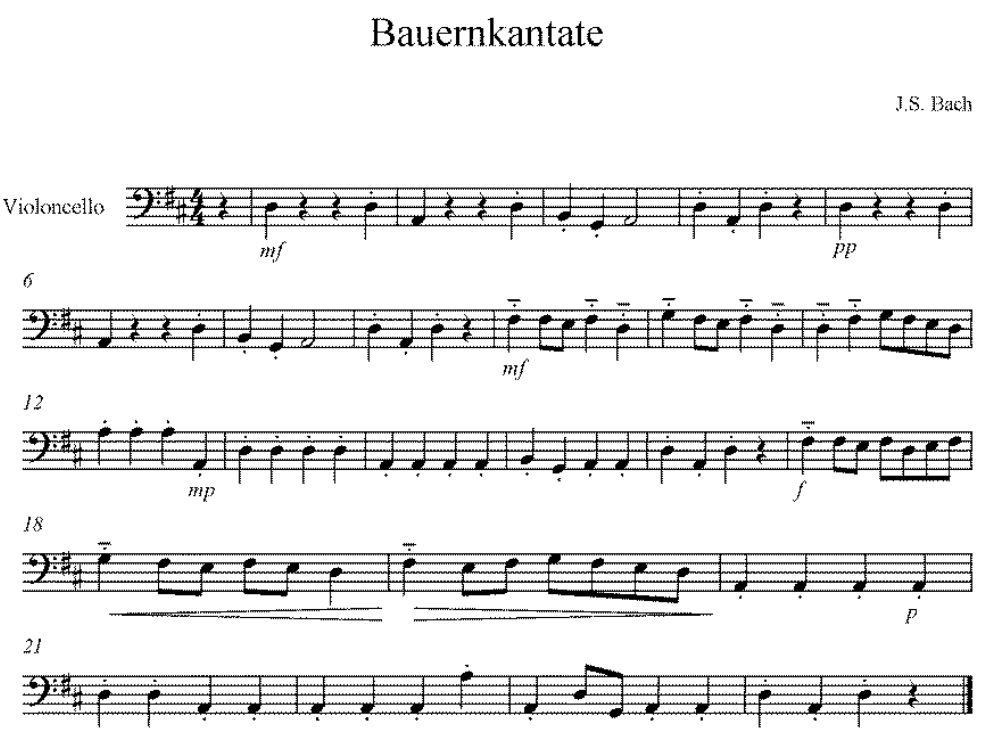


Appendix 2: *Andante* by Edward Elgar. Violoncello score

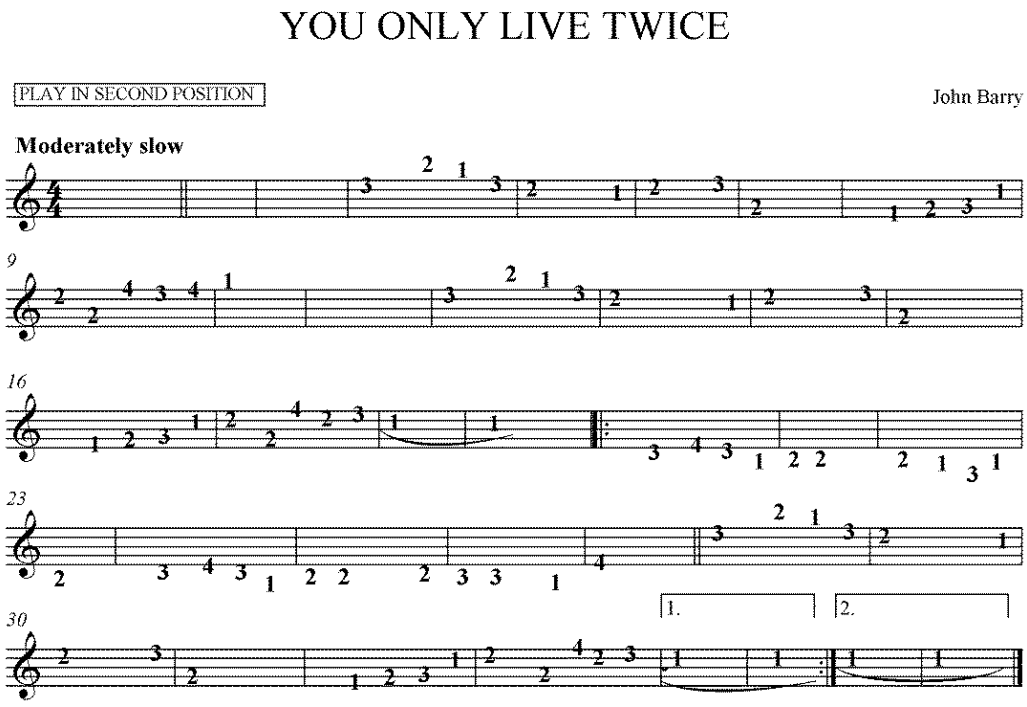


Appendix 3: An excerpt from the J.S. *Bach`s Bauernkantate* . The violin 2 score

Appendix 4: An excerpt from J.S. *Bach`s Bauernkantate.* The violoncello score



Appendix 5: *You Only Live Twice* melody written in a special notation style



Appendix 6

Table 1. Player information. First grade students

Player numbers in the tests	Gender	Instrument	Age years	Years in music school	Entrance examin-ation sco-res	Shared piece pre-testing scores	Annual examin-ation scores
Player 1	Girl	Violin	10	3	73	4,5	4
Player 2	Boy	Violin	12	3	78	4,5	4
Player 3	Girl	Violin	11	4	75	5	6
Player 4	Girl	Cello	11	3	74	-	-
Player 5	Girl	Violin	12	3	66	4	4
Player 6	Girl	Violin	11	4	77	4	4
Player 7	Girl	Cello	10	2	73	-	-
Player 8	Girl	Violin	9	2	74	7	7
Player 9	Girl	Viola	14	4	62	4,5	4
Player 10	Girl	Cello	13	5	66	-	-

Appendix 7

Table 2. Player information. Second grade students

Player numbers in the tests	Gender	Instru-ment	Age, years	Years in music school	Entrance examination scores	Shared piece performance Means of estimators	Annual examin-ation scores
Player 11	Girl	Violin	11	6	73	6	7
Player 12	Girl	Violin	16	8	78	3	4
Player 13	Boy	Violin	12	6	75	5	4
Player 14	Girl	Violin	11	5	74	5	4

Appendix 8: Characterising *You Only Live Twice* by two teachers

(The score: see appendix 5)

Estimator 4: a violin and viola teacher

Estimator 6: a violoncello teacher

Estimator 4:

- The perceiving of the key influences the atmosphere of the playing
- The fingerings in second positions
- The playback gives the pulse for the duration of long notes
- The playback gives the pulse for the duration of long notes
- Phrasing should be accomplished according to the rhythm, triplets are important in this respect
- Figuring the nuances or differences in dynamics arise from harmony and the rhythms
- How to hold up in long notes,
- What type and character of *vibrato* is appropriate?

Estimator 6:

- How to use the bow to generate good legato-like character
- How to produce appropriate vibrato
- How to play along together with the Cd

- Triplets are important
- Holding up in long notes, the type and quality of *vibrato*

Appendix 9: Characterising *Bauernkantate*

(The score: see appendix 3 and 4)

Estimator 4: a violin and viola teacher

Estimator 6: a violoncello teacher

Estimator 4:

- Bar 4: very clear terrace dynamics
- Bar 7. Using bow length and bow places makes the rhythm more elastic
- From bar 17: strong legato playing

Estimator 6:

- Dynamic changes
- Managing the rhythm in fast figuring
- Chancing the notes in good timing together
- Fast and vivid bow moving, light and *staccato*

Appendix10: Characterising Edward Elgar *Andante*

(The score: see appendix 1 and 2)

Estimator 4: a violin and viola teacher

Estimator 6: a violoncello teacher

Estimator 4:

- In the beginning the violinist informs when and in which pulse to begin to play
- Does the title (andante) tell the tempo and feeling of the music?
- Do the players know the composer, the music history related to the music?
- The students should understand the outline of the huge differences in dynamics
- Crescendo-diminuendo lines are easy to carry out with the bowing style

- Bar 8-11: strong feelings
- Bar 16: the violoncello tells the pulse. The last note together with violoncello.
- Bar 17 is like the beginning, note the same pulse with viola
- A more tranquil feeling after the emotional storm
- Bar 19: bow movement between strings evenly

Estimator 6:

- Slow, persistent bowing style makes good, steady sound
- Plenty of dynamics
- The same rhythm in different parts, note that they change at the same time
- Ritardando, listening to a moving sound progression
- Good intonation is needed, based on good sound of the harmony

Appendix 11. Guidelines for estimators. Elgar *Andante*

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Instructions for the estimators**
v0	The performance as whole	
v1 (Tempo and pulse)	Find and keep tempo according to the character and atmosphere of the music	
v2 (Tempo and pulse)	Keep the basic pulse throughout the whole piece of music	
v3 (Tempo and pulse)	Communicate the tempo and pulse right from the start	
v4 (Tempo and pulse)	Express nuances within the basic pulse	In crescendo passages, for instance, the tempo should not be accelerated unnecessarily
v5 (Style and general structure)	Be aware of one`s leadership and sustain it throughout the playing	
v6 (Style and general structure)	Find the style and atmosphere right from the start	Peaceful, ”floating”music. Singing character.
v7 (Style and general structure)	Find and communicate the general structure of the music	Bar 17: knowing and communicating that the music is the same as in the start
v8 (Style and general structure)	Communicate strong musical feelings to the group	Bar 8-12: strong feelings, slowing down, diminuendo in the end
v9 (Dynamics and phrasing)	Find and express dynamic marks	

v10 (Dynamics and phrasing)	Find and play long dynamic changes	In bars 5-11 a long sustainable crescendo
v11 (Dynamics and phrasing)	Communicate large dynamic changes	
v12 (Dynamics and phrasing)	Active phrasing and communicate phrasing to the group	
v13 (Left hand)	Position and relaxation of left hand	
v14 (Left hand)	Motoric skills of left hand fingers	
v15 (Left hand)	Tonally based intonation	
v16 (Left hand)	Rich sound production with good left hand finger technique	For instance the finger pressure on the string
v17 (Right hand)	Appropriate sound production with bow technique	
v18 (Right hand)	Singing detache bow style	
v19 (Right hand)	Communicating the bow style to the group	In the beginning and bar 17-18 together with the viola and bar 16 together with violincello
v20 (Right hand)	Using the bow to express crescendo and diminuendo lines	
v21 ”Primas” skill	Leading the group by playing	The abilty to take a role as a leader of the group

Appendix 12. Guidelines for estimators. Bauernkantate

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Instructions for the estimators**
v0	The performance as a whole	
v1 (Tempo, rhythm and pulse)	Find tempo and pulse according to the music	
v2 (Tempo, rhythm and pulse)	Hold tempo and pulse	
v3 (Tempo, rhythm and pulse)	Playing rhythms in good pulse	
v4 (Tempo, rhythm and pulse)	Good timing in changes of notes	
v5 (Style and big picture)	Finding the style and atmosphere from start	
v6 (Style and big picture)	Find the big picture of the piece of music	
v7 (Style and big picture)	Adjust the nuances with melody	

v8 (Style and big picture)	Adjust the accompaniment score to changes in expression	
v9 (Dynamics, and phrasing)	Read and express dynamics appropriately	
v10 (Dynamics, and phrasing)	Reading and playing"Terrace dynamics"	
v11 (Dynamics, and phrasing)	Adjust dynamics to melody score	
v12 (Dynamics, and phrasing)	Adjust phrasing to melody score	
v13 (Left hand technique)	Intonation	
v14 (Left hand technique)	Using vibrato in appropriate style	
v15 (Left hand technique)	Good fingering technique in legato quavers	For instance bar 11, 18 and from bar 21 onwards
v16 (Left hand technique)	Elasticy in playing large intervals	
v17 (Right-hand technique)	Sound quality according to the character of the music	
v18 (Right-hand technique)	Good control in detache and legato bowing styles	For instance strong lega-to playing style from bar 17 onwards
v19 (Right-hand technique)	Good division in bowing technique	
v20 (Right-hand technique)	Using appropriate length, speed, press and articulation in bowing style	
v21 (Reading the score)	Keep reading in play-together situation	
v2 (Reading the score)	Keep playing in play-together situation	
v23 (Reading the score)	Read bowings and rhythms	
v24 (Reading the score)	Read and play correctly notes and rests	
v25 Play-together skills	Playing together as an accompa-nying player	Ability to follow the first violin and possibly the violoncello scores while playing

Appendix 13. Guidelines for estimators. You Only Live Twice

Separate Variables (appropriate skill group in parenthesis)	**The skills**	**Instructions for the estimators**
v0 (The perfor-mance)	Performance as a whole	
v1 (Tempo and pulse)	Moderately slow tempo, start	Tempomarking: moderately slow
v2 (Tempo and pulse)	Managing tempo and pulse through the whole music	The notation is referential. The lengths of the notes are expressed with smaller or larger room after them
v3 (Style, atmosphere and big picture)	Catch the style and atmosphere from start	
v4	Master the big pic-	In the passage B more passionate feeling, A1

(Style, atmosphere and big picture)	ture	returning to the atmosphere of the beginning.
v5 (Left hand technique)	Intonation	The second position is challenging for second grade players, the playing of the intervals, low third fingers have been market with flat marks. How to classify C major and F minor
v6 (Left hand technique)	Vibrato in appropriate style	Expressing the emotional content of the music with vibrato, for instance between A-B-A1 pasages
v7 (Right-hand technique)	Adequate tone production	The speed and division of the bowings, holding the sound steadily
v8 (Right-hand technique	Characterize the tone with bowing technique	The colouring of the nuances
v9 (Right-hand technique	Good technique of singing bow	
v10 (Right-hand technique	Using left and right hand together in music expression	Changing the rate of vibrato according to the atmosphere and dynamics of the music
v11 (Reading)	Reading special notation	
v12 (Reading)	Creating rhythm in special notation	How coherent and systematic is the playing of the rhythmic figures in the special notation style of the score

Appendix 14. Permission for video recordings

Permission for video recordings

Pirkko Juntunen has permission to use video recording of my child to be used for evaluation made by string teachers and also to be shown blurred in conferences. The videos will not be shared in the Internet. The videos can be sent via email for the own families.

Name of the student …….

In Nummela ……./……2012

The parents signature

……

Clarification of the signature……

Original publications