The Use of Virtual Musical Instruments in Timbre Recognition Training

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***Abstract*—The article describes research conducted on children and teenagers in Youth Palace in Olsztyn, Poland. The research was conducted for one school year in two groups: experimental and control. It relates to the practical use of virtual instruments in timbre ear training, which was applied during additional keyboard classes. The time reserved for weekly tests and teaching several timbres of musical instruments recognizing was quite short, so that each attempt took around 7 minutes. The experiment time was strictly limited due to curriculum of Keyboard classes, which required to be fully realized. In that case, experiments had to be conducted in a way, which would not affect the classes. Purposeful use of virtual instruments in teachers' work in the context of timbre recognition, increases the effectiveness of the educational process, so that children obtain very good results in recognizing different instruments' timbres in contrast to the control group. It should be assumed, that the certain time spent on musical instruments timbre recognizing would cause way greater skill growth of research group. Data obtained clearly indicates the importance of education conducted in this way, due to its affection on timbre consciousness shaping.**

***Keywords*—education, hearing, teaching, timbre, virtual studio technology instruments**

I. Introduction

For the last several years we have been observing a very rapidly progressing process of digitization and computerization of almost every area of human life, which is also having an impact on music [1]. Thanks to the development of digital technologies in music production, we can see better and better quality of reproduction of digital sound which is a result of virtual instrument emulation (VSTi) [2]. The result is that the sound imitated by the software is getting more and more difficult to distinguish from the acoustic model instrument [3, 4].

The process of digitization should not be skipped by music teachers in general and specialized education [5], [6]. Conscious use of digital technologies during classes is a very valuable skill for a music teacher, that can have a very big impact and can bring tangible results in educating the children [7, 8] in the area of processing and recognizing the timbres of individual musical instruments [9, 10].

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II. Assumptions and Purpose of the Experiment

The purpose of the experiment was to examine if the use of VSTi during the keyboard classes has an impact on the musical memory of the participants resulting in getting better results in recognizing the timbres of selected musical instruments in comparison to the control group.

III. Sound Material

In the experiment, the teacher was presenting different melodic and harmonic passages in different pitch scales (natural for every instrument), for no longer than 10 seconds. The instructor performed the parts in front of the participants randomly (in a different way every time), to avoid making the listeners get used to the performed melody in connection with the timbre.

The teacher was performing the melodic parts on the virtual instruments emulating the traditional ones in a very precise way. To check participants' knowledge about the timbres of individual instruments, the instructor chose 25 timbres of acoustic instruments from among many instrument types: violin, viola, cello, double bass, trumpet, trombone, French horn, tuba, acoustic guitar, electric guitar, bass guitar, banjo, mandolin, drum kit, glockenspiel, bagpipe, piano, harp, harpsichord, tenor saxophone, soprano saxophone, transverse flute, recorder, piccolo flute and church organ.

For every instrument listed above there was one way of articulation chosen for timbre presentation – legato. In the case of the drum kit, the teacher performed a rhythm in 4/4 time signature, that was using the sounds of different parts of said kit.

IV. Equipment and Software Used during the Listening Sessions

The listening sessions were conducted in room 312, where keyboard classes take place in the Youth Palace in Olsztyn, Poland. The listening station consisted of the following elements:

(1) Portable computer Asus X515JA-BQ3747W (version: i7-1065G7, 16GB RAM, 512GB SSD) with Windows 10 Home and Digital Audio Workstation software – Cubase 11 Pro installed along with EastWest virtual instruments.
(2) Audio/MIDI interface Steinberg UR 22 mkII.

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(3) Studio monitors M-audio BX8 D3.
(4) Yamaha PSR-700SX keyboard, which was used exclusively as a MIDI controller, connected to the computer using a USB cable [11].

The loudness of the played stimuli was set by the teacher before the beginning of the study, the loudness setting of the sound assured maximum comfort during the listening session for all gathered listeners. The loudness was set once as the same for all the groups, was not changed during the whole research period and was approximately 75 phons.

V. Listeners and Data on the Research Group

In the entire experiment participated a total of 40 people were divided into two groups: research and control. The groups were made through random selection among the class participants [12, 13].

The research group consisted of 20 people aged 8 to 12 years old, including 8 boys and 12 girls. All of them were people who had no previous contact with any kind of music education. To verify the veracity of the data obtained as a result of the experiment conducted in the research group, it was decided to create another, second group – control.

The control group consisted of another, randomly chosen 20 people aged 7 to 14 years old, including 12 boys and 8 girls. Just as in the research group, they were people without any earlier music education.

VI. Listening Sessions

The school year in Poland begins annually on September 1st (month marked as I in Table I), and ends at the end of June (month marked as X in Table I), then in July and August, children and young people in Poland do not come to classes, as it is a period free from school (summer holidays). In the school year 2021/2022, for 10 months, participants of both groups attended the classes in groups of 4 – once a week, with every lesson lasting 45 minutes. The first test of both groups' participants' knowledge took place in September (month marked as I in Table I), during the first class, before the actual beginning of music education.

In the case of the research group, training listening sessions were conducted every single week in a group of 4 (each Friday). Said group took each subsequent test in accordance with the schedule of conducting the subject in this institution, on the first Friday of every month.

In the control group, no training listening sessions were conducted, while next timbre recognition tests were held in January (month marked as V in Table II) and June (month marked as X in Table II), on the first Friday of chosen months.

VII. The Method of Conducting the Classes and the Experiment

The method of conducting the classes in the research group:

(1) Each knowledge test was held at the very beginning of the class, once a month, and lasted approximately 7 minutes.
(2) Every week training listening sessions were conducted, lasting about 7 minutes. In the case when knowledge test and training listening session coincided – for the first 7 minutes participants' knowledge was checked, and then, after collecting the results, a training listening session was conducted for about 7 minutes.
(3) The remaining approximately 30 minutes were used according to the curriculum to teach playing popular music pieces on keyboard. This part of the lesson did not relate to the experiment and focused solely on correct keyboard teaching.

The method of conducting the classes in the control group:

(1) Each knowledge test was held at the very beginning of the class, 3 times a year, and lasted approximately 7 minutes.
(2) The remaining approximately 37 minutes were used according to the curriculum to teach playing popular music pieces on keyboard. This part of the lesson focused solely on correct keyboard teaching.

The knowledge test consisted of 25 previously prepared timbres. The teacher was choosing a random timbre and presenting it in an unplanned way, no longer than 10 seconds. For the next 10 seconds, the participants had time to note the name of the musical instrument, the timbre of which they managed to recognize, on a blank piece of paper. The process was repeated for each of the 25 instrument timbres. It was not a test of choice (lack of suggestions), in this way the children that did not know the answer did not write the name of any instrument. After the test, the instructor was collecting all the papers with the answers from participants and checking the results after the class [13, 14].

VIII. Results

Table I presents data showing the percentage of correctly given answers by the respondents in the research group. The correct answer is understood as the proper recognition of the timbre of the sound by the children. Table I shows the progress in the area of timbre recognition by every one of 20 participants of the experiment, in the context of training time divided by months. Table I presents the test results obtained from the beginning of the experiment (September) until its completion (June). Proper timbre identification of one instrument is equal to (and is listed in the table as) 4%, of two instruments to 8%, of three instruments to 12% etc.

Table II presents data showing the percentage of correctly given answers by the respondents in the control group. This group did not participate in weekly training sessions. In this case, the group of 20 people was tested three times: in September, January, and June.

TABLE I. DATA PRESENTING THE PERCENTAGE OF CORRECT ANSWERS GIVEN BY THE RESPONDENTS, OBTAINED IN THE RESEARCH GROUP

Children	Month									
	I	II	III	IV	V	VI	VII	VIII	IX	X
	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
	in %									
1	8.0	20.0	32.0	44.0	52.0	60.0	72.0	80.0	84.0	84.0
2	4.0	20.0	32.0	40.0	48.0	56.0	72.0	80.0	88.0	92.0
3	8.0	24.0	32.0	48.0	56.0	60.0	70.0	80.0	88.0	88.0
4	4.0	12.0	20.0	28.0	36.0	48.0	56.0	64.0	72.0	80.0
5	8.0	16.0	32.0	48.0	56.0	72.0	80.0	88.0	96.0	96.0
6	20.0	40.0	56.0	72.0	84.0	96.0	100.0	96.0	100.0	100.0
7	12.0	20.0	28.0	44.0	56.0	64.0	72.0	76.0	80.0	84.0
8	16.0	32.0	48.0	56.0	68.0	80.0	92.0	100.0	96.0	100.0
9	8.0	16.0	24.0	40.0	48.0	52.0	60.0	68.0	72.0	80.0
10	8.0	16.0	28.0	44.0	56.0	68.0	76.0	84.0	92.0	92.0
11	0.0	8.0	16.0	24.0	32.0	48.0	52.0	56.0	60.0	64.0
12	4.0	8.0	16.0	32.0	40.0	52.0	60.0	64.0	68.0	68.0
13	8.0	16.0	32.0	44.0	52.0	64.0	76.0	84.0	88.0	92.0
14	4.0	16.0	24.0	32.0	40.0	48.0	56.0	64.0	72.0	80.0
15	12.0	24.0	36.0	52.0	60.0	68.0	80.0	88.0	96.0	100.0
16	4.0	16.0	32.0	48.0	56.0	64.0	80.0	88.0	96.0	100.0
17	0.0	8.0	12.0	20.0	24.0	28.0	36.0	44.0	48.0	52.0
18	4.0	16.0	32.0	44.0	56.0	68.0	76.0	84.0	88.0	92.0
19	8.0	16.0	24.0	32.0	44.0	56.0	68.0	76.0	80.0	84.0
20	12.0	24.0	36.0	40.0	48.0	60.0	72.0	80.0	88.0	92.0

TABLE II. DATA PRESENTING THE PERCENTAGE OF CORRECT ANSWERS GIVEN BY THE RESPONDENTS, OBTAINED IN THE CONTROL GROUP

Children	Month		
	I	V	X
	Sep.	Jan.	Jun.
	in %		
1	4.0	8.0	4.0
2	8.0	4.0	8.0
3	0.0	0.0	0.0
4	4.0	12.0	4.0
5	12.0	12.0	16.0
6	8.0	16.0	12.0
7	4.0	4.0	8.0
8	16.0	20.0	12.0
9	8.0	16.0	8.0
10	20.0	20.0	20.0
11	8.0	12.0	8.0
12	4.0	0.0	4.0
13	8.0	4.0	4.0
14	12.0	16.0	8.0
15	8.0	8.0	8.0
16	16.0	16.0	20.0
17	4.0	4.0	4.0
18	4.0	0.0	4.0
19	4.0	8.0	4.0
20	0.0	4.0	0.0

Table III presents data on the progress in timbre recognition in both groups. The progress in both cases reflects the difference between the last and the first test result (June–September).

TABLE III. DATA REVEALING THE PROGRESS IN THE FIELD OF TIMBRE RECOGNITION FOR EACH PERSON PARTICIPATING IN THE STUDY, ALONG WITH THE AVERAGE FOR A GIVEN GROUP

Children (research group)	Progress (in %)	Children (control group)	Progress (in %)
1	76.0	1	0.0
2	88.0	2	0.0
3	80.0	3	0.0
4	76.0	4	0.0
5	88.0	5	4.0
6	80.0	6	4.0
7	72.0	7	4.0
8	84.0	8	−4.0
9	72.0	9	0.0
10	84.0	10	0.0
11	64.0	11	0.0
12	64.0	12	0.0
13	84.0	13	−4.0
14	76.0	14	−4.0
15	88.0	15	0.0
16	96.0	16	4.0
17	52.0	17	0.0
18	88.0	18	0.0
19	76.0	19	0.0
20	80.0	20	0.0
Average	78.4	Average	0.2*

*Within the range of the statistical error.

IX. DISCUSSION OF RESULTS

It is worth pointing out that the biggest problems with the auditory recognition of the timbre of a given instrument were caused by the groups of instruments characterized by a specific and at the same time similar

timbre class. The respondents often confused the timbres of:

(1) Violin and viola (especially in close pitch scales, where these instruments can sound alike).
(2) Double bass and cello, sometimes with tuba (especially in close pitch scales, where these instruments can sound alike).
(3) Double bass and bass guitar (because of a timbre similarity).
(4) Acoustic guitar with banjo and mandolin (some timbre similarities exist).
(5) All brass instruments (many participants treated every one of these instruments as a trumpet).
(6) Recorder with transverse flute and piccolo flute (depending on the pitch scale, the respondents combined the occurring similarities and assigned them to one instrument that they could not precisely define).
(7) Tenor and soprano saxophone (playing the melody in closer pitch scales, resulted in higher number of mistakes or lack of answers, whereas the more the instruments were separated from each other by the pitch scale, the more often correct answers occurred).

In the case of the control group results, the obtained data indicate a statistical error, which is often about a "lucky guess". That means, that the respondent not always actually recognized the timbre, but tried to guess it – which is represented by the data in Table II. Some of the participants in the control group do indeed recognize few timbres of the instruments they know, but in their case, the lack of training sessions results in a lack of progress in terms of identifying the timbre.

The results clearly indicate that the method of conducting classes concerning the recognition of the timbres of various musical instruments, through the use of VSTi, brings specific and measurable effects [15] in comparison to the control group. It is worth pointing out that, in general, the best recognized instruments were the ones as electric guitar, trumpet, drum kit, glockenspiel, bagpipe, piano, harp, harpsichord, and church organ – after only 2–4 training sessions, the participants more and more often recognized the instruments correctly.

X. Conclusion

The research that was conducted for the purposes of this paper shows the importance and relevance of the discussed problem, resulting from the maladjustment of the music education program to the thriving technological development of the contemporary world. This article is a response to the emerging needs, standards and challenges in the field of broadly understood music education. Dynamic computerization and digitization process in our society becomes an impulse for a new perspective on children and youth education, thanks to which, it is possible to broaden children's knowledge in the area of recognizing the timbre of individual musical instruments, in an interesting way, using appropriate computer software [16].

The lack of relevant, professional literature makes this topic difficult for many teachers to study. Increasing awareness and factual knowledge allows the use of virtual instruments in an educational context to a greater and greater extent, which enables the exchange of experience among people involved in teaching at various levels of education [17]. Furthermore, the issues that are the guiding principle of this study can be expanded and researched in the field of using virtual instruments in broadly understood music education, in the ear training in music schools, as well as in developing the compositional and arranging skills of young artists [18]. The discussed topic is very broad and multifaceted, as it shows issues that can be subjected to further experimentation and reflection.

XI. Research Extension

Experiments conducted in the Youth Palace in Olsztyn showed, that timbre recognition training using virtual musical instruments has measurable results in participants' recognition of the timbres. Unfortunately, the teaching of the Keyboard subject in Poland, according to the curriculum, is focused on playing songs with correct fingering, sight reading sheet music, basic concepts of harmony and music theory, but not on any kind of ear training. The duration of the listening sessions (7 minutes) was chosen by the researcher in a random way. The primary goal for the author of the experiment was to try measuring and verifying the occurrence of a given phenomenon, without any loss in a didactic value of the Keyboard classes. Results obtained from the experiment are very promising and show the need of change in the curriculums of the Keyboard subjects – they should be extended and include elements of ear training. It can be assumed, that increasing the time of musical training is reasonable and the education can be widened by adding many new elements, which may cause more intensive progress of the students. Extended ear training will further stimulate auditory skills, which in the future will lead to better and more versatile education for the graduates.

Conflict of Interest

The author declares no conflict of interest.

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