

10th ICEEPSY 2019
International Conference on Education and Educational Psychology
THE COMPARISON OF THE KEYSTROKE TECHNIQUE
BETWEEN PIANISTS AND ORGANISTS

Ondrej Hromadko (a), Petr Spacek (b)*, Kristyna Soukupova (c), Nela Viktorova (d)

*Corresponding author

(a) Faculty of Education, University of Hradec Kralove, Rokitanskeho 62, 500 03 Hradec Kralove III, Czech Republic. E-mail: ondrej.hromadko.2@uhk.cz

(b) Faculty of Education, University of Hradec Kralove, Rokitanskeho 62, 500 03 Hradec Kralove III, Czech Republic. E-mail: petr.spacek.2@uhk.cz

(c) Faculty of Education, University of Hradec Kralove, Rokitanskeho 62, 500 03 Hradec Kralove III, Czech Republic. E-mail: kristyna.soukupova.2@uhk.cz

(d) Faculty of Education, University of Hradec Kralove, Rokitanskeho 62, 500 03 Hradec Kralove III, Czech Republic, E-mail: nela.viktorova@uhk.cz

Abstract

The research focuses on keystroke technique differences between pianists and organists. The keystroke characteristics (length and speed) during different hand/arm positions could reveal several differences in relation to the keyboard height. Considering the specifics of playing both instruments, the aim is the comparison of fine-motor parameters between pianists and organists. The assessed sample is repeated playing of C major scale using the right hand. The important criterion is the dynamics difference and its impact on the keystroke. The research was conducted with the keyboard STUDIO LOGIC 88 GRAND, enabling neutral conditions for independent measurement. Moreover, the software CUBASE PRO 9.5 was chosen for sample transformation to exact data. The research focused on the hand position in relation to the angle of its posture. The result validity was verified using the questionnaire. Particular differences in the finger technique of both groups were proved. Nevertheless, the same initial piano preparation leads to similar keystroke technique. The dynamics changing during playing the scale is neutral considering its quality. The differences in the spatial orientation change were revealed. The organ players were more flexible than the piano players when the keyboard position was changed. The similarities and differences of the keystroke technique of the organists and pianists are significantly influenced by the previous piano preparation in case of organists. Moreover, the fluent playing in the unusual keyboard height is best supported by the practical organ preparation. The research results can be used for the methodological and pedagogical purposes and for further scientific research.

© 2019 Published by Future Academy www.FutureAcademy.org.UK

Keywords: Dynamics, fine-motor control, keystroke techniques, organ, piano, upper limb position.

1. Introduction



Piano and organ are in terms of playing technique both classified as keyboard instruments. They have a common technique of playing (keystroke). Nevertheless, in terms of tone and its colour these are completely different instruments. While in case of piano the key moves the hammer to chime the stretched string (in the descant position of the string), in case of organ the air flows to the pipe of the corresponding register and height, creating a tone of already given strength and timbre. In the classification of musical instruments, the piano belongs to the percussion keyboard chordophones and the organ to the polyphonic keyboard aerophones (Modr, 2006).

Alexejev (1988) mentions Elias Ammerbach (presumably 1530 - 1597), the late Renaissance German organist: The art of organ playing must be prioritised over others, since it is applicable not only to one instrument. Those who can play it can also use it on positive organs, regals, virginals, clavichords, clavicembalos, harpsichords and other similar instruments. The distinction was made only for genre purposes, i.e. spiritual or secular, not for playing technique. During the Baroque period, the differences between the organ and the emerging piano with its sensitive mechanics were more defined. Therefore, the organ players were not advised to play the piano concurrently in order not to destroy the delicate finger technique (Alexejev, 1988). Many habits of the keyboard instrument playing spread throughout Europe (Ouyang, 2017). The differences between playing the piano and the organ have been described many times in the literature and are not the subject of this article.

The organists, on the other hand, are expected to have an advanced and still developing piano playing technique. Klinda (1983) exemplifies the famous French organist and teacher of the 20th century, Marcel Dupré, who required the applicants for his organ classes to play also the piano, specifically Fryderyk Chopin Etudes, at the entrance examinations. Šlechta (1989) confirms that the better and faster the organist's ability to play the piano, the easier it will be to overcome the difficulties in organ compositions studying. The influence of the piano technique is also remarkable in organ compositions by composers from the Romanticism to the present (César Franck, Ferenc Liszt, Max Reger, etc.).

The research is part of the continuous scientific work of the Music Department of the Faculty of Education of the University of Hradec Králové, Czech Republic. It develops the awareness of the latest knowledge in the field of performing art and interpretation among the future Music and Instrument playing teachers (Špaček & Sedláčková, 2014). A part of scientific research at the University of Hradec Králové examined also the relationship between the physiognomic and psychological foundations of performing arts (Lorenc, Juklová, & Vaniček, 2018), similar to interdisciplinary research in the field of memory and music interconnection (Besedová, 2018). The support of the technical staff of University of Hradec Králové, Czech Republic is also very important.

2. Problem Statement

The research focus was a statistical comparison of the differences in the fingerstroke of the piano and organ players in relation to the physical non-musical factors. Therefore, the research is conceived as quantitative, based on the predetermined hypotheses (Olecká & Ivanová, 2010).

For both groups (pianists and organists) it is important to practice the right fingering. When playing both instruments, one technical problem can be solved according to the specifics of the other instrument, because the piano and the organ have some common technique elements. Fingering

(irrespective to the difference in tone formation) is undoubtedly an essential moment in the scale and passage playing both instruments. Other similar features comprise the silent replacement during the consistent legate playing and the padless backing technique. The scale playing in particular is the main research question, within which the following variables are observed: the strength of the keystroke, the length of the keystroke and the speed of switching of the individual tones (time gaps between tones). The sound balance - and the associated hand position and finger participation - represents one of the main requirements of piano playing (Nejgauz, 1983). Appropriate exercising leads to a relatively perfect fingering technique. Therefore, the piano (while keeping one dynamic range) achieves a smooth sound that is naturally reached on the organ and other keyboard instruments. In case of organ, it is necessary to care about the exact keystroke beginning and its release even more consistently due to the indefinite beginning and ending of the tone depending on the air in the whistle. This issue is also researched by the latest research of this topic at the Music and Dance Faculty of the Academy of Performing Arts in Prague (Tůma, 2016).

The research sample was solely the adult population, which after the traditional focus of music education on the child population becomes a specific and highly desired group of a music research. The project involved teachers, PhD students and the recent graduates from the Master programmes Instrument Playing and Solo Singing within the specialised modules Piano and Organ Playing.

In total, 30 people including 15 pianists and 15 organists participated in the data collection. All organists have many years of experience playing the piano.

First, each player played the C major scale fifteen times with his or her right hand over two octaves in legate, tempo ♩ - 100 MM and uniform mezzoforte dynamics in ascending and descending directions on the keyboard and the spatial position. Then again the same 15 times on the same keyboard in the new position. This particular spatial change of the instrument is very important for this research.

3. Research Questions

The research hypotheses based on the nature of measurable variables in piano and organ playing were established as follows:

- H1: There are no statistically significant differences between particular musicians.
- H2: There are no statistically significant differences relating to the type of musician.
- H3: There are no statistically significant differences relating to the position of the keyboard.

The aim of the research was to confirm or reject the abovementioned hypotheses that can co-create a new perspective of instrument methodology and preparation.

4. Purpose of the Study

The purpose of the study was to research the topic mentioned above. This represents particular issues connected with the examining playing the keyboard in different settings. The change was in the distance as well as in the height and the organists as well as pianists were tested how they manage such a change in relation to their keystroke.

5. Research Methods

The methodology complies with the international standards for the quantitative research and is based primarily on the statistical data and numbers (Olecká & Ivanová, 2010). The nature of the research is primarily statistical. The description of the research method is designed in such way in pursuit to avoid errors and inaccuracies. Moreover, the ambiguous interpretation is eliminated and of course, the research rules are followed (Ševčíková, 2015).

5.1. Technology and Measuring Instruments

The practical research was carried out on the electronic keyboard instrument STUDIO LOGIC 88 GRAND allowing excellent neutral conditions for independent measurements. Moreover, the software CUBASE PRO 9.5, which converted the collected samples into accurate data relevant for the comparative statistics and overall evaluation, was employed. The collected data were then quantified in the programme Statistika and recorded in the worksheets. The data processing was performed using the statistical tests including Brown-Forsythe Test ANOVA, Levene's Test and Two Sample t-Test.

5.1.1. The Impact of the Keyboard Height

One of the fundamental conditions of the research measurement was the position of the keyboard. A precondition for relatively authentic measurement was the standardised height of organ manuals according to the international organ standards from 1967 (Bělský, 1984). The keyboard during measurement was therefore set to a default height of 76 cm. After recording the first round of the samples, the keyboard was placed at the level of the third organ manual, i.e. raised by 12 cm at an external height and moved by 20 cm apart. This created a new environment for the players, in which their hands had to cope with the unnatural position and play at the same quality as at the height of the first organ manual.

All musicians performed 5 C major scale with their right hand only in a sitting position and under two different conditions. The conditions varied in the angle of the arm and elbow. Moreover, the distance between the keyboard and the ground was changed. Under the first condition, the participants performed while the upper limb was in the normal (piano) position. The arm was extended about 45 degrees and the forearm parallel to the ground. Under this condition, the distance between the keyboard and the ground was 76 cm. Under the second condition, the arm was extended forward about 110 degrees and the elbow extended about 150 degrees. Under this condition (organ) the distance between the keyboard and the ground was 88 cm.

The C major scales were performed in a medium loudness (mezzoforte) and legato. The speed was set to four notes per beat (sixteenth notes) and a metronome beating in 100 bpm was used. The participants were instructed to play as precise as possible.


At the end all participants were asked to fill in a questionnaire focusing on the demographics and other music-related information.

5.1.2. The Research Sample

The unified sample was playing the C major scale in the range of two octaves in the range of c1 to c3 (in the measurement statistics keys c5 to c7). The research sample is based on the theory of relations between tones of tempered scale, which is the basis of the European music culture (Karafiátová & Luska, 2018). The scale was played in total five times at both positions, requiring the ideal fingering for the scale of the 1st fingering group. The idea of using the basic scale playing was based on the general assumption that mastered scale fingering is one of the basic elements of playing keyboards.

The fingering of the scale is provided in Figure 1.

C MAJOR



sempre legato e mf

SCALE C MAJOR UP:
 note:
 c⁵ - d⁵ - e⁵ - f⁵ - g⁵ - a⁵ - h⁵ - c⁶ - d⁶ - e⁶ - f⁶ - g⁶ - a⁶ - h⁶ - c⁷
 fingering:
 1 - 2 - 3 - 1 - 2 - 3 - 4 - 1 - 2 - 3 - 4 - 1 - 2 - 3 - 4 - 5

SCALE C MAJOR DOWN:
 note:
 c⁷ - h⁶ - a⁶ - g⁶ - f⁶ - e⁶ - d⁶ - c⁶ - h⁵ - a⁵ - g⁵ - f⁵ - e⁵ - d⁵ - c⁵
 fingering:
 5 - 4 - 3 - 2 - 1 - 3 - 2 - 1 - 4 - 3 - 2 - 1 - 3 - 2 - 1

Figure 01. Instructions for playing (Authors, 2019)

5.2. Laterality Test and Questionnaire Method

Firstly, Matějček - Žlab's standardised laterality test was conducted with all respondents (Šestáková, 2015). This confirmed the genotypic right-handedness in case of all participants. The majority of them performed in full or nearly full extent all test tasks with the right hand.

The validity of the results was verified through the distribution of a questionnaire among all respondents. The questionnaire focused on respondents' feelings during the research measurement (perception of comfort, the impact of the keyboard position on the quality of playing, the impact of the repetition frequency on fatigue, technical parameters) and their current instrumental practice (piano, organ or both). The questionnaire included closed questions with answers on the Likert scale (rating method). The process of measuring and compiling the questionnaire was based on the principles of recent psychometric survey (Ceresia & Mendola, 2017).

6. Findings

Firstly, the hypotheses were defined to be accepted or rejected by the measurement. Recording of the respondents provided the audio tracks. These were further measured and analysed. Then, the statistical methods revealed comprehensible results which are described and compared in the following tables (Table 01, 02, 03, 04, and 05). Moreover, the overall summary including the commentary is provided.

The outputs are stored in the project documentation and are available for further purposes.

Table 01. Overall statistical analysis of both groups, pianists and organists

		Mean		Count	Range	Percentile			p-value	
		Value	95% Confidence Interval			25	Median	75		
Type	Pianist	68,09	(67,72;68,46)	4353	1 - 119	60	69	77	0,686 ^{NS}	
	Organist	68,21	(67,79;68,62)	4347	1 - 108	61	70	77		
Position	Normal	68,82	(68,44;69,19)	4355	1 - 108	62	70	77	<0,001*	
	High	67,48	(67,08;67,89)	4345	1 - 119	60	69	77		
Position/Type	Normal	P	68,25	(67,76;68,75)	2176	1 - 99	61	70	76	0,004*
		O	69,38	(68,81;69,94)	2179	1 - 108	62	70	78	
	High	P	67,93	(67,38;68,48)	2177	21 - 119	60	69	77	0,030**
		O	67,03	(66,44;67,63)	2168	1 - 102	60	69	76	

^{NS} – not significant, * – significant at 0,01 alpha value, ** – significant at 0,05 alpha value
 P – pianist, O – organist

6.1. The Average Speed of the Keystroke in Normal and Higher Position

Firstly, the average pace rate within the groups, i.e. between all pianists and all organists, was compared.

Table 02. Testing the difference in average keyboard speed for each group separately Group Statistics

Org		High	N	Mean	Std. Deviation	Std. Error Mean
Pianist	Speed	Normal	2176	68,25	11,720	0,251
		High	2177	67,93	13,028	0,279
Organist	Speed	Normal	2179	69,38	13,560	0,290
		High	2168	67,03	14,166	0,304

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
P	Equal variances assumed	22,275	0,000	0,860	4351	0,390
	Equal variances not assumed			0,860	4303,610	0,390
O	Equal variances assumed	2,196	0,138	5,571	4345	0,000
	Equal variances not assumed			5,570	4334,701	0,000

P – pianist, O – organist

In case of pianists, there is no difference in the average speed of the keystroke in the normal and higher position of the keyboard ($p = 0.390$). Whereas in case of organists, the average speed of the keystroke is significantly higher in the normal position ($p < 0.001$).

Then, the speed of the keystroke between these two groups, i.e. between pianists and organists, was compared.

Table 03. Testing of the difference in the average keystroke speed in normal and elevated position

Group Statistics						
High		Org	N	Mean	Std. Deviation	Std. Error Mean
Normal	Speed	Pianist	2176	68,25	11,720	0,251
		Organist	2179	69,38	13,560	0,290
High	Speed	Pianist	2177	67,93	13,028	0,279
		Organist	2168	67,03	14,166	0,304

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	T	Df	Sig. (2-tailed)
Normal	Equal variances assumed	19,446	0,000	-2,919	4353	0,004
	Equal variances not assumed			-2,919	4265,288	0,004
High	Equal variances assumed	2,293	0,130	2,177	4343	0,030
	Equal variances not assumed			2,177	4309,888	0,030

Hypothesis 2 (there are no statistically significant differences depending on the type of the musician) is not rejected in Two Sample t-Test. Pianists and organists prove the differences expressed in the tables above.

6.2. The Correlation between the Note Length and the Keystroke Speed

The examination of the correlation between the note length and the keystroke speed for each note individually proved the surprising facts. Within the latter, the average keystroke in each group was analysed in detail from the keystroke perspective.

Table 04. The correlation between the note length and the keystroke speed for both groups according to each played note

Note	Pianists			Organists		
	Correlation	P-value	N	Correlation	P-value	N
c5	-0,059	NS	301	-0,140	0,015	305
d5	0,256	<0,001	300	0,226	<0,001	300
e5	-0,247	<0,001	300	0,121	0,036	298
f5	0,352	<0,001	300	0,467	<0,001	300
g5	0,120	0,038	300	0,258	<0,001	300
a5	0,309	<0,001	300	0,230	<0,001	300
b5	-0,195	<0,001	301	0,292	<0,001	300
c6	0,247	<0,001	300	0,536	<0,001	297
d6	0,496	<0,001	301	0,251	<0,001	299
e6	-0,316	<0,001	300	0,038	NS	300
f6	0,483	<0,001	300	0,627	<0,001	297
g6	0,388	<0,001	300	0,545	<0,001	298
a6	0,356	<0,001	300	0,279	<0,001	299
b6	-0,074	NS	300	0,324	<0,001	299
c7	0,244	0,003	150	0,154	NS	152

In both groups, the strongest positive correlations (longer tone = faster keystroke) are highlighted in green. The orange values indicate significant negative correlations (longer tone = weaker keystroke).

The measurement showed the relationship between the length of the note and the speed of the finger keystroke, which is the most noticeable when underlaying. What is essential in this respect is the handling of the underlay. For piano players, the speed of the finger is reflected on the keys that precede it. The keystroke softens at that moment (orange values) and lightens, so that the underlaying keystrokes continue in their uninterrupted keystroke force and speed. The organ players always show the longest keystroke on the underlaying keystroke (green values), as it is pressed. The other keys have normal keystroke force values. These results were very surprising. Moreover, they can possibly represent interesting topic for the research focused on this phenomenon in particular.

6.3. Confirmation/Rejection of Hypotheses

The following list overviews the hypotheses and the results derived from them.

- H1: This hypothesis is rejected. Based on post-hoc tests, the average keystroke speed varies from person to person.
- H2: This hypothesis is accepted. The average keystroke speed is comparable for both groups, i.e. the type of musician generally does not matter (the differences are therefore more among individuals than in the type of musician).
- H3: This hypothesis is rejected. The differences in the average keystroke velocity are significant - according to the calculated descriptive characteristics, the keystroke velocity is higher in the normal position than in the higher position.

6.4. Playing Comfort Questionnaire

The questionnaire distributed after playing was focused on the comfort and convenience of playing under different conditions. It included the following questions.

1. Is it comfortable for you to play in the normal keyboard position?
2. Is the playing still comfortable for you in the changed position?
3. Does the position change affect the playing quality?
4. How much did you have to focus on fingering in another position?
5. Have you experienced tiredness during multiple repetitions?
6. Do you face similar conditions in your practice?

Respondents were given the questionnaire above. The answers were selected from the options within the following scale:

- a) certainly not - b) rather not - c) rather yes - d) certainly yes

The responses are recalculated as a percentage of the responses within and between groups.

Table 05. Results of the questionnaire survey relating to the comfort in normal and increased position of the keyboard

Questions		No 1	No 2	No 3	No 4	No 5	No 6
Answers (in %)	Pianists (15 people)	a) 100 % b) 0 % c) 0 % d) 0 %	a) 20 % b) 53 % c) 20 % d) 7 %	a) 13 % b) 13 % c) 67 % d) 7 %	a) 20 % b) 33.5 % c) 33.5 % d) 13 %	a) 27 % b) 20 % c) 40 % d) 13 %	a) 100 % b) 0 % c) 0 % d) 0 %
	Organists (15 people)	a) 100 % b) 0 % c) 0 % d) 0 %	a) 0 % b) 13 % c) 67 % d) 20 %	a) 40 % b) 53 % c) 7 % d) 0 %	a) 33 % b) 27 % c) 27 % d) 13 %	a) 20 % b) 27 % c) 40 % d) 13 %	a) 0 % b) 0 % c) 7 % d) 93 %
	All participants (30 people)	a) 100 % b) 0 % c) 0 % d) 0 %	a) 10.5 % b) 33 % c) 43.5 % d) 13 %	a) 27 % b) 33 % c) 37 % d) 3 %	a) 27 % b) 30 % c) 30 % d) 13 %	a) 23.5 % b) 23.5 % c) 40 % d) 13 %	a) 50 % b) 0 % c) 3 % d) 47 %

The results expressed in percentage show responses within and between groups. According to the results, a significant difference in the perception of comfort and convenience when playing in a normal and higher position was confirmed. This difference was observed in both groups. For organists, the change of position did not have such a great impact on their perception of comfort. On the contrary, the pianists perceived the change in the position of the keyboard as significantly worse. The pianists hardly dealt with the discomfort, they were doubly convinced that a change in position affected the quality of their playing. Moreover, they had to concentrate slightly more on fingering. Interestingly, the change of position also influenced the mechanical memory, which works normally in common playing of the scales. None of the pianists said they face such conditions in their common practice. For organists, position changing is a normal phenomenon, which is related to the technical disposition of the musical instrument (Bělský, 1984). Nevertheless, they considered playing in a higher and more distant position to be much less comfortable than playing in a normal position. According to their answers, the change of position did not significantly affect the quality of playing. They did not have to concentrate on fingering with the excessive effort. Furthermore, such playing did not tire them.

6.5. Potential Deviations

The members of the research team are aware of deviations connected with the measurement. It could be caused by the current mental and physical condition of the individual respondents. There was no case within the respondents that would have not noticeably and illogically correspond with the other results. Therefore, the possible deviations are negligible and still relevant for the scientific research. The feedback in form of a questionnaire with the direct determination of responses on the Likert scale did not allow any inaccurate interpretation.

7. Conclusion

The research results of the Music Department of the Faculty of Education of the University of Hradec Králové, Czech Republic confirmed the hypothesis of differences in physical characteristics of the keystroke for piano and organ players. The pianists use lighter keystroke technique when playing fast, and organists show a stronger keystroke (see details in Table 05). This confirms that the piano technique is generally more delicate, while in case of the organ (especially historically valuable and older instruments)

greater keyboard resistance has to be overcome. The recent scientific research has already confirmed that when comparing the fingers of three or more players, the ratio of notes played with the same fingers increases, but only slowly (Nakamura, Saito, & Yokshii, 2019). The correlation between the note length and keystroke speed has revealed very interesting results and it would be desirable to address and develop this topic within the further research.

An unusual phenomenon is the change of the keyboard position, which pianists do not experience under normal conditions, while the organists are able to cope with the change of position very quickly and easily thanks to the different positions of the organ manuals. The experiment with position changing of the keyboard determined the perception of comfort, which also varies between pianists and organists. When changing the position of the keyboard, the fatigue and certain loosening in the mechanical fingering appear, the player is forced to be more careful.

It is also important to note that a great deal of the “success” of each group is always the individual. Therefore, further investigation could be more focused on links of individual players to particular variables. This research fulfilled its aim: to measure, average and describe the specific physical characteristics of two groups studied and compare their results. Other possibilities are still open thanks to high-quality research equipment acquired through the internal grant support of the University of Hradec Králové, Czech Republic.

Acknowledgments

Support from the Specific Research of the Faculty of Education of University Hradec Králové, ‘Komparace úhozové techniky u hráčů na klávesové nástroje (‘The Comparison of the Keystroke Technique of Keyboard Instrument Players’), n. 2130/01510/2017, is gratefully acknowledged.

References

- Alexejev, A. D. (1988). *История фортепианного искусства I*. [Dějiny klavírního umění I.] Moskva: Muzyka.
- Bělský, V. (1984). *Nauka o varhanách*. [Organ Theory.] Praha: Supraphon.
- Besedová, P. (2018). The Anatomical Foundations of Music Perception by Non and Foreign Language Learners. *The European Proceedings of Social & Behavioural Sciences*, 53, 104-112. (online) <https://doi.org/10.15405/epsbs.2019.01.10>
- Ceresia, F., & Mendola, C. (2017). Psychometric Properties of a Questionnaire Measuring the Antecedents of Entrepreneurship Education Intention. *The European Proceedings of Social & Behavioural Sciences*, 31, 742-754. <https://doi.org/10.15405/epsbs.2017.10.71>
- Klinda, F. (1983). *Organová interpretácia*. [Organ Interpretation.] Bratislava: Opus.
- Lorenc, J., Juklová, K. & Vaníček, F. (2018). The Contexts of Organ Performance Education in Selected European Countries. *The European Proceedings of Social & Behavioural Sciences*, 53, 664-671. (online) <https://doi.org/10.15405/epsbs.2019.01.64>
- Karafiátová, M. & Luska, J. (2018). Intratonální hierarchizace melodického hudebního materiálu v ontogenezi: aplikace metody zkušebního tónu. [Intra-Tonal Hierarchy of Melody in Development: Probe-Tone Method and Its Application.] *Musicologica Olomucensia*, 28, 63-81. (online) <http://new.musicologicaolomucensia.upol.cz/wp-content/uploads/2015/06/Musicologica-Olomucensia-28-2018.pdf>
- Modr, A. (2006). *Hudební nástroje*. [Musical Instruments.] Praha: Editio Bärenreiter.

- Nakamura, E., Saito, Y., & Yoshii, K. (2019). Statistical Learning and Estimation of Piano Fingering. *IEEE/ACM Transactions on Audio, Speech, and Language Processing*, XX(XX), 1-13. (online) Retrieved from <https://arxiv.org/pdf/1904.10237.pdf>
- Nejgauz, G. G. (1983). *O umění klavírní hry*. [The Art of Piano Playing.] Praha: Státní pedagogické nakladatelství.
- Olecká, I., & Ivanová, K. (2010). *Metodologie vědecko-výzkumné činnosti*. [Methodology of Scientific and Research Activities.] Olomouc: Moravská vysoká škola Olomouc.
- Ouyang, J. (2017). *The influence of the English pianoforte on keyboard technique and composition from 1790 to 1826*. Manchester: Manchester Metropolitan University (online) Retrieved from <https://espace.mmu.ac.uk/id/eprint/620029>
- Šestáková, V. (2015). *Lateralita u žáků primární školy*. [Laterality of Primary School Pupils.] Olomouc: Univerzita Palackého. (online) Retrieved from https://theses.cz/id/3vvz3g/DP_Sestakova.pdf
- Ševčíková, V. (2015). *Studentské odborné texty jako problém*. [Student Professional Texts as a Problem.] Ostrava: Ostravská univerzita.
- Šlechta, M. (1989). *Metodika varhanní hry*. [Methodology of Organ Playing.] Praha: Státní pedagogické nakladatelství.
- Špaček, P. & Sedláčková, T. (2014). On the Issues of the Correct Vocal Tract Configuration in a Specific Voice Education Process. *e-Pedagogium*. II(2014), 49-60. (online) Retrieved from <https://e-pedagogium.upol.cz/pdfs/epd/2014/02/05.pdf>
- Tůma, J. (2016). *O interpretaci varhanní hudby s přihlédnutím k jiným klávesovým nástrojům*. [The Interpretation of Organ Music with Regard to Other Keyboard Instruments.] Praha: 2HP Production s.r.o.