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Michele Della Ventura, *editor*

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Preface

This volume of proceedings from the conference provides an opportunity for readers to engage with a selection of refereed papers that were presented during the International Conference on New Music Concepts, Inspired Education and New Computer Science Generation. The reader will sample here reports of research on topics ranging from a diverse set of disciplines, including mathematical models in music, computer science, learning and conceptual change; teaching strategies, e-learning and innovative learning, neuroscience, engineering and machine learning.

This conference intended to provide a platform for those researchers in music, education, computer science and educational technology to share experiences of effectively applying cutting-edge technologies to learning and to further spark brightening prospects. It is hoped that the findings of each work presented at the conference have enlightened relevant researchers or education practitioners to create more effective learning environments.
This year we received 57 papers from 19 countries worldwide. After a rigorous review process, 24 paper were accepted for presentation or poster display at the conference, yelling an acceptance rate of 42%. All the submissions were reviewed on the basis of their significance, novelty, technical quality, and practical impact.

The Conferece featured three keynote speakers: Prof. **Giuditta Alessandrini** (Università degli Studi Roma TRE, Italy), Prof. **Renee Timmers** (The University of Sheffield, UK) and Prof. **Axel Roebel** (IRCAM Paris, France).
I would like to thank the Organizing Committee for their efforts and time spent to ensure the success of the conference. I would also like to express my gratitude to the program Committee members for their timely and helpful reviews. Last but not least, I would like to thank all the authors for they contribution in maintaining a high-quality conference and I hope in your continued support in playing a significant role in the Innovative Technologies and Learning community in the future.

March 2020

Michele Della Ventura

Conference Chair

Michele Della Ventura, Accademia Musicale Studio Musica, Treviso, Italy

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Renee Timmers, The University of Sheffield, UK
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Education through Music Analysis and Mathematics: Chopinesque Melodic Structures in Étude Op. 25 No. 2

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Abstract. Educators teach the notion of melody in a variety of music courses from analytical, historical, and performative perspectives. This research presents an alternative methodology of how students can comprehend the melodic aspect of musical composition through the integration of music theory and mathematics in Chopin's Étude Op. 25 No. 2 in F minor. Appropriate for students who are well versed in music analysis, this innovative pedagogy allows one to subdivide a musical line and analyze each segment separately while focusing on voice leading and motivic direction of each segment. Analytically, the results allow one to trace a particular set of melodic patterns and dissect Chopin's compositional approaches. Pianistically, the results can help achieve a well-balanced musical interpretation. Pedagogically, the proposed analytical system for viewing the work generates a project-based educational environment in the classroom.

Keywords. Chopin, music analysis, music and mathematics, music education.

1 Introduction

A melody is a component of music that generates a unique compositional language and presents one with essential information about a composer's work. The notion of melody is prominent to performers, theorists, and musicologists, as instructors provide instructions on this topic in all levels of music education. In music appreciation courses, pedagogues define the melody as one of the essential and most fundamental elements of music, where the students learn the rudiments of forming, structuring, and combining melodies with other musical aspects. In analysis courses, students examine melodies from a theoretical perspective by applying a variety of techniques to evaluate a given musical excerpt [1]. In the field of musicology, students view and interpret the concept of melody from the context of various stylistic epochs and how composers influence the history of music by engraving their compositional patterns in own works.

There are many sources that educators may rely on to teach the concepts of melody, such as the books by Burstein and Straus (2016), Kostka and Payne (2017), and Berkowitz (2017) [2-4]. Due to the organicist nature of music history, melodies are likewise prominent in the atonal repertoire. Straus, for instance, presents the notion of a musical

contour as an analytical method, which can outline the shape and the form of an atonal tune [5]. Instructors may furthermore turn to Schenkerian studies to teach melodic analysis at a variety of graduate-level theory courses, amalgamating the melodic, harmonic, and contrapuntal components of a given work [6].

This research focuses on an alternative approach to define a melodic structure in music through the interdisciplinary studies of music analysis and mathematics by focusing on a work by a prominent Romantic composer. This paper will introduce an innovative method of dissecting the primary melodic material from Chopin's Étude Op. 25 No. 2 through a unique set of analytical methods. This study utilizes an empirical approach to define the compositional patterns in the melodic formation of the Chopin's étude. From the pedagogical perspective, such a practice will allow students to understand the significance of the melody in the context of the entire work. A motivic analysis will be used to subdivide the melody and explain Chopin's compositional choice for the primary thematic material. It is important to note that such an innovative pedagogical outlook is appropriate for students that are well versed in music theory and can comfortably examine the melody analytically and artistically. It is also recommended that students who are involved with this musical practice possess the appropriate music technology skills, as well as can apply non-musical technology in the context of music education and empirical studies on music. Therefore, such educational tactics will serve of most benefit when applied to the AP Music Theory curriculum at high school level and to courses that cover the areas of musicianship, analysis, and theory at the university level.

2 Étude Op. 25 No. 2: Background

Frédéric Chopin (1810-1849) was an acclaimed Romantic composer, known for distinct compositional style and an ability to produce lyrical and expressive melodies. An étude is a musical work that allows a musician to refine and enhance a particular technique (or in certain instances – a set of techniques.) Chopin composed a total of twenty-seven piano études, each unique from performative, analytical, and musicological points of view. The twelve works in the Op. 10 collection, completed by 1833, the twelve works in the Op. 25 collection, completed by 1837, and the three lone compositions without an opus number as part of *Trois Nouvelles Études*, completed in 1839, combine to form Chopin's comprehensive oeuvre for the genre of études – a set of short works, yet challenging technically and musically, and requiring a broad depth of understanding in the context of performance practice. The melodic analysis of Chopin's primary thematic material has often appeared in the spotlight of previous scholarly publications, as seen in the works of Hoyt (1982), Phipps (1983), and Bellman (2000) [7-9]. Mathematical applications to Chopin's music can be observed in Tymoczko's *Chopin's Tesseract* (2011) [10].

Nicknamed *The Bees* and defined by the various polyrhythmic structures, this is a fast étude in cut time, composed in the key of F minor. Pianistically, there are multiple suitable interpretations of this étude with applauded recordings by Maurizio Pollini, Valentina Lisitsa, and Claudio Arrau. The performance time of Op. 25 No. 2 is approximately one and a half minutes, making this work one of the shortest études in Chopin's

compositional repertoire.

3 Étude Op. 25 No. 2: The Educator's Perspective

Pedagogically, this piece is unique because of the following three features. First, Chopin applies *perpetuum mobile* for right and left hands, signified through a continuous stream of notes without any break, not allowing either of the hands to rest during the entire performance, as seen from Figure 1. Such a compositional application presents technical challenges for pianists, especially for works in fast tempi. Likewise, such an approach to music composition can be observed in a plethora of Chopin's works throughout his career, most notably in the final *Presto* movement of his Piano Sonata No. 2 in B♭ minor, Op. 35.

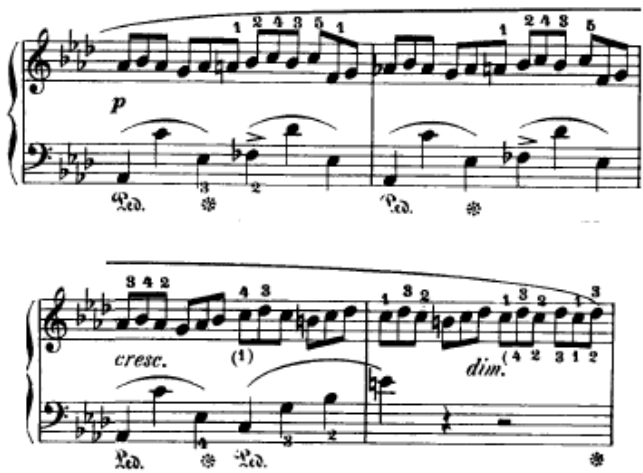

Fig. 1. Chopin's Étude Op. 25 No. 2, mm. 16-19.

Second, Chopin employs a unique rhythmic structure through the use of triplets, where the right hand, the melody, contains four sets of eighth-note triplets in each measure, while the left hand, the harmony, contains two sets of quarter-note triplets in each measure. While such a phenomenon is evident from an analytical standpoint, it is in the pianist's best interests to avoid revealing it in order to carry a smooth and elegant performance. Pianistically, although the rhythm is, indeed, a protruding part of Chopin's style of composition, performance practice traditions permit a certain amount of freedom when dealing with tempo deviations. Such changes in speed generate numerous interpretive readings of Chopin's works – an evident phenomenon, especially in Chopin's études due to several intentionally-presented artistic and technical pianistic challenges.

Third, Chopin shapes the curvature of the melody's harmonic support through the use of short slurs. Figure 2 shows the anacrusis and the opening three measures of the work with

the initial melody in the right hand and a series of short musical segments in the left hand, amalgamating the right hand's primary thematic material with the left hand's harmonic support, a pattern that continues throughout the entire composition [11]. Emphasizing the musically-slurred melody is an instance of both technical and interpretational complexities that a pianist faces during the performance [12].

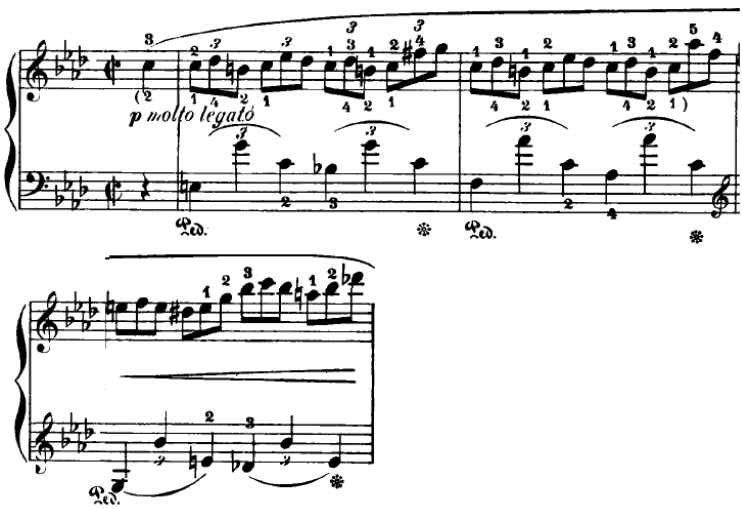

Fig. 2. Chopin's Étude Op. 25 No. 2, mm. 1-3.

4 Dissecting the Melody

The melody in this work is influenced by the application of perpetuum mobile, the use of triplets, and phrasal development through the means of slurs. These features are prominent in the construction of the work's melodic skeleton, allowing Chopin to make some of the exclusive compositional choices not seen in his other études. However, similarly to other works of this genre, the whole composition can be divided into three sections. The A-section spans for thirty-six measures, as seen in mm. 1-36, the B-section spans for fourteen measures, as seen in mm. 37-50, and the A`-section spans for nineteen measures, as seen in mm. 51-69. The A-B-A form is the instance of consensus in the structure that Chopin chooses for much of his compositional output.

Each measure contains four groups of eighth-note triplets in the right hand against two groups of quarter-note triplets in the left hand. The two sets of triplets in the right hand, combining for a total of six notes and spanning for a half a measure, will be represented as a motive *m*. Therefore, each measure is a combination of 2*m* that generates twelve notes in the melody of each such measure. These can likewise be divided into four partial motives of three notes, where notes #1-3 and #7-9 will be defined as m_1, and notes #4-6 and #10-12 will be defined as m_2, hence $m = m_1 + m_2$. Therefore, m_1 denotes a

partial motive occurring on the strong beats of each measure, such as the first and the third beats, while m_2 symbolizes a partial motive occurring on the weak beats of each measure, such as the second and the fourth beats. Figure 3 shows a sample m_x analysis of mm. 4-7, where each m_1 component generates a resolution towards an m_2. Each measure consists of two sets of m_1 and m_2, while each hyper-measure consists of four sets of m_1:m_2 resolutions.

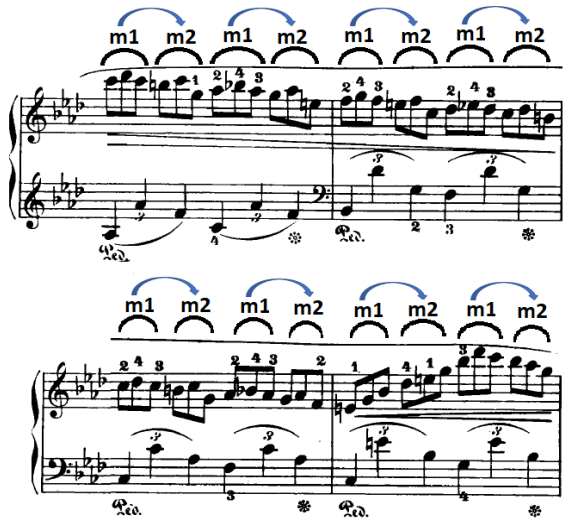

Fig. 3. Chopin's Étude Op. 25 No. 2, mm. 4-7.

The finale of Op. 25 No. 2 in mm. 68-69 of the composition does not structure in a tantamount m_1-m_2-based theory and, therefore, is excluded from the analysis, as its function is to conclude the melodic expansion and to arrive at the final cadence, hence a total of sixty-seven measures of primary melodic material are utilized. The motion from m_1 to m_2 is of most significance in this study. The direction of each partial motive impacts the flow and the construction of the entire work since the compositional tactics outlined by Chopin in the melody are likewise carefully supported by the harmony in the left hand. The $2m_x$ of each measure generates a total of 134(m_1) and 134(m_2), yet this étude merely contains 26 unique m_1 and 42 unique m_2 values due to a high frequency of reinstated m_x. Table I presents the data with the four most common m_1, its respective resolutions to m_2, and the exact locations of such occurrences throughout the étude.

TABLE I: THE FOUR MOST COMMON RESOLUTIONS IN CHOPIN'S ÉTUDE OP. 25 NO. 2.

[C-D♭-B]	[C-E♭-D♭]	m. 1; m. 2; m. 9; m. 10; m. 20; m. 21; m. 28; m. 29; m. 51; m. 52; m. 59; m. 60
	[C-F#-G]	m. 1; m. 9; m. 20; m. 28; m. 51; m. 59
	[C-A♭-F]	m. 2; m. 10; m. 21; m. 29; m. 52; m. 60
	[C-A♭-B♭]	m. 64
[C-D♭-C]	[B-C-G]	m. 4; m. 6; m. 23; m. 25; m. 43; m. 54; m. 56
	[B-C-D♭]	m. 18; m. 19; m. 37; m. 49; m. 50
	[D♭-G-A]	m. 38; m. 39; m. 40
	[B♭-C-G]	m. 12; m. 31
	[G-A♭-B♭]	m. 14; m. 33
	[D♭-C-D♭]	m. 19; m. 50
	[D♭-F-E♭]	m. 64
[B♭-C-B♭]	[A-B♭-D♭]	m. 3; m. 22; m. 53; m. 61
	[C-F-G]	m. 16; m. 17; m. 35; m. 36
	[A-B♭-B]	m. 39; m. 40
	[A-B♭-F]	m. 11; m. 30
	[A-B♭-C]	m. 41
[A♭-B♭-A♭]	[G-A♭-E]	m. 4; m. 13; m. 23; m. 32; m. 43; m. 45; m. 54
	[G-A♭-A]	m. 16; m. 17; m. 35; m. 36
	[G-A♭-F]	m. 6; m. 25; m. 56
	[G-A♭-B♭]	m. 18; m. 37

5 Results

The data generates a total of four observations. First, the most common m_1 is [C-D♭-B]. Such m_1 resolves into an m_2 a total of 25 times, which encompasses over 18% of all m_1-m_2 resolutions. Chopin begins this étude with [C-D♭-B] and turns it into the most common thematic material seen in the right hand. The [C-D♭-B] is particularly prominent in the opening and closing sections of the work. The A-section contains four separate phrases in mm. 1-8, mm. 9-19, mm. 20-27, and mm. 28-36, where each phrase begins with an m_1. The A`-section contains two separate phrases in mm. 51-58 and mm. 59-69. The [C-D♭-B] motive initializes each of these phrases and likewise serves the purpose of sub-phrase initialization and phrasal continuation throughout the étude. Chopin's emphasis on [C-D♭-B] is evident, as he continues to reinstate this m_1 throughout the whole work. In analytical terms, this is merely a reordered subset of a chromatic scale, and Chopin can utilize such a simple motivic element to create a masterpiece. Another reason for its prominence is the need to create a constant sense of dissonance and resolution due to a high level of chromaticism. The third element of the triplet, the B♮, is a raised fourth scale degree in the key of F minor that requires an immediate resolution. The B♮ generates a tritonal melodically-dissonant framework when centered alongside note F, the tonic; Chopin does that to create the necessity for musical tension – a central and an imperative component of the implication-realization (IR) model, allowing the B♮ to gravitate towards the note C [13-15].

Second, [C-D♭-C] is the m_1 that Chopin utilizes to generate the most variety of resolutions. In this étude, [C-D♭-C] produces a total of 7 unique realizations. In [C-D♭-C], the first and the third elements represent the fifth scale degree – the dominant. Chopin

chooses to stay as close as possible to the fifth scale degree by employing a neighbor tone, D ♭ , that is located a half a step higher, which allows for a smoother transition into the proceeding m_2. A total of 12 out of 22 resolutions resolve to B (as in the first element of m_2) and 6 resolutions resolve to D ♭ (as in the first element of m_2). Therefore, 18 out of 22 resolutions generate a motion of a half step. This is an example of Chopinesque chromaticism – a significant module of his musical characterization and a unique stylistic feature of his pianistically-based compositional manner.

Third, the four most commonly used m_1 are [C-D ♭ -B], [C-D ♭ -C], [B ♭ -C-B ♭], and [A ♭ -B ♭ -A ♭], all of which generate a necessity for a resolution 76 times, covering a total of 56.7% of all possible resolutions. Repetition in music indicates musical significance, and Chopin commonly employs [C-D ♭ -B], [C-D ♭ -C], [B ♭ -C-B ♭], and [A ♭ -B ♭ -A ♭] as m_1 to allow the pianist to emphasize on them artistically and creatively – another instance of Chopin's ability to present a simple motivic segment and use it to construct a musical composition [16].

Fourth, the vast majority of the m_1 to m_2 resolutions occur by a half or a whole step. When analyzing the intervallic range of the third note of each m_1 and the first note of each m_2, Table I reveals that a distance of a semitone or a whole step occur in all instances, except in the case of [C-D ♭ -C] to [G-A ♭ -B ♭] motion, which is seen in merely two occurrences in the étude. Such small-scale resolutions disclose a unique outlook that a composer chooses for his melodic contour of the primary thematic material. Such small-scale resolutions likewise present an insight into the analytical organization of pitches in the context of tonality and musical chromaticism.

6 Conclusion

The results that such analysis holds are useful for theorists, performers, and educators. For theorists, this is an analytical approach that allows searching for prominent musical material, its weight in the music, and how the motives throughout the piece behave in relation to one another. The chromatic nature of this work undoubtfully creates a plethora of harmonic opportunities that Chopin explores through multiple patterns of melodic resolutions, as seen through the behavior of m_1:m_2 relations. For performers, such analysis allows for generating own musical interpretations. Historically, Chopin's études underwent a great deal of artistic evolution when looking from the perspective of performance practice, and the application of musical contrast to the motivic segments that Chopin emphasizes will make one's view of this piece unique and exclusive [17]. An empirical musical comprehension of a Romantic work presents alternative artistic choices that one can make at a performance.

For educators, such a technique to analyze the melody can successfully be used in advanced-level music theory courses to further broaden students' understanding of this work's form, harmony, chromaticism, and musical language. This approach can be implemented in a project-based environment, allowing the students to view Op. 25 No. 2 from a pragmatic research-based perspective. Students will be able to apply their technology, analysis, critical thinking, and problem-solving skills in the context of empirical

musicology, looking for theory-based patterns that can explain Chopin's strategy to a melodic outline of the étude. Students may use MuseScore, Finale, Sibelius, or any other notation editors, and integrate it along with computational analysis through Excel, R-programming, or similar software [18, 19]. Students would need to extract the primary thematic material, dissect the rhythmic pattern of the étude, bifurcate the melodic component of the right hand based on m_1:m_2 structure, and analyze for patterns that shape the melodic plans and strategies that Chopin chose for this composition.

Finally, this analysis is likewise significant in piano pedagogy, allowing the students to combine a variety of motives in both hands and practice them separately. Future research using this analytical approach can be aligned with other Chopin's études with similar melodic construction. In Op. 10, for instance, examples of works with evident motivic expansion include Études No. 1 (C major), No. 44 (C♯ minor), and No. 5 (G♭ major). Furthermore, the similar analytical technique is useful when dissecting music by other composers influenced by Chopin, such as Alexander Scriabin's Op. 8 and Franz Liszt's Transcendental Études [20, 21].

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