Kernel: A Basis in Analyzing the *Tiniglalaki*, a Panay Bukidnon Dance Music

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ABSTRACT

This research makes use of "kernel", or the waiting time to establish the proper timing in playing musical instruments. The author examines kernel in the music of "tiniglalaki" (for a man and his partner) that is used in the binanog (hawk-eagle dance) among the Panay Bukidnon of Western Visayas, Philippines. Through an ethnomathematical approach, this quantitative way of analyzing beats of music aligns with the way Bloch (1987) studied kernel functions, which can be plotted from structural properties and inherent attributes of a studied mathematical space. On the other hand, the author also utilized ethnography, a qualitative way to examine local characteristics, that is, the local people's music and breathing sequences to understand kernel patterns. The research finds that the sequences of sounds and the "waiting time" in music provides for preparation between the actions of producing sounds. The purpose of the research is to understand human expression in relation to sound production though mathematical analysis.

Introduction

The highland people of Panay in Western Visayas, Philippines, are called Panay Bukidnon. Philippine anthropologists Jocano (1968) and Magos (1995 and 1999) have built the scholarship of about these people and also have written about their social kinship, societal structure and cultural life. However, it was Tolentino (2005) and Muyco (2016) who have written about their *binanog*, or hawk-eagle music and dance. This is a productive means to strengthen community bonding as it forges interaction and camaraderie. The *binanog* can be danced by a solo female, which is called *"tinigbabayi"*; or with a partner, e.g., male-female, termed as *"tiniglalaki"*. Its music is the focus of this study. Although *tiniglalaki* literally means a male-centered cultural expression, its use for a partner dance reinforces the courtship stage of Panay Bukidnon couples.

Figure 1. Rene Gilbaliga danced the tiniglalaki with Estela Gilbaliga in a gathering of the Panay Bukidnon community in Barangay Garangan, Iloilo.

According to Tolentino (2005), the *binanog* is a traditional form of music and dance expression. It defines the bond of a community in rites of passage, particularly in formal courtship. It is in *tiniglalaki* that a man can get oriented of the woman that he is about to be married to. This is usually the case of arranged marriages or in rare instances, the woman of his choice. Sometimes, parents give the Panay Bukidnon male an option to assess and decide on his life partner.

An extension of this study conducted by Muyco (2016) further explored binanog as she found an ideology of practice called "sibod". Sibod means an operational instance when music and dance are well synchronized, thus motivating the audience to participate by vocalizing the rhythms. The Panay Bukidnon animate sibod by thinking of structure, which is linguistic in nature. Through language such as repeated phrases with accents and syllabications, rhythmic patterns are formed and are played through their gong-and-drum musical instruments.

Muyco (ibid) explains how *sibod* organizes music, breathing, and dancing. As researcher, I view these latter factors as bases for understanding 'kernel' as a mathematical phenomenon. Kernel is the waiting time to establish the proper timing in playing musical instruments. In this study, I examine kernel in the music of "tiniglalaki" already defined earlier employing kernel functions, which as explained by Bloch (1987), can be plotted from structural properties and inherent attributes of a studied mathematical space. In this study, such space is examined between musical notes.

Figure 2. A husband and wife tandem. In this photo, Federico Caballero and Lucia Gilbaliga Caballero play the gong together but with different stick techniques.

As a researcher, I conducted this study about kernel in 2005 in the community of Barangay Garangan in Calinog, Iloilo, one of the areas where the Panay Bukidnon people are located. Their chieftain, Mr. Federico Caballero and his wife, Mrs. Lucia Caballero, another respected figure in their community, introduced me to the *tiniglalaki* dance music, which is played on gong, drum, wood percussion, and accompanying vocables. Such dance music brings life to the Panay Bukidnon. As much as it preserves their way of life as it is connected to the formation of a family and the succeeding stages of birthing, living, and dying (in short, the people's lifecycle events), it is the very substance of expression, that is, the 'human expression' that I give credence to. I believe that it is in the spirit of human expression that determines the character and uniqueness of an artform. There are many ways to explain this spirit of expression. However, this study used a mathematical approach to bring out the aspects of this human expression that are understood through music as well as the body that acts on or activates sound and energy.

Given that there is sound and silence in music, I look at in particular the 'presence' and 'essence' of silence represented through "intervals" or the distance between two notes that represent sound. On the other hand, intervals are perceived as silence or "rest".

There are various intervals in mathematics. A set of points represent the combination of open or close configurations in these intervals. The interval could be [a, b], (a, b),[a, b), (a, b], (, b], (, b),[a, ∞), (a, ∞), (-∞, ∞).

A function takes every element from a particular domain and assigns it to a unique element in the range. Kernel is a special type of function that assigns identity to an element in the domain. The Boolean function (Rosen, 1998) is another type of function that takes an element from the domain to a set with only two elements B={0,1}. This function is used in this study to indicate that a note is used or not. The note is assigned to one (1) when it is used and zero (0) when it is not used. Kernel in this study is a portion of the measure where notes are not played. One or more types of rests can be included within the kernel. The following shows the concept of function and kernel in the study of this music,

Equation (1) $$f([j,k)) = \begin{cases} 1 & if\_played \\ 0 & if\_not\_played \end{cases}$$

Consequently, if a note is used in the music ([j, k)→1), it will be played; otherwise, that note will be silent (([j, k)→0). On the other hand, kernel, if it exists, is a set of unsound units. A kernel is not played in the portion of the measure. Thus the kernel is,

Equation (2) $$\ker([j,k)) = \{[j,k) / [j,k) \to 0\}$$

In this study, I link the identity of notes--sounded or not in a set--to Fraleigh's "Identity element" (1999). This is an element that when operated with any element in a set gives a result that is the element itself. Thus, for any element a∈S, an identity element e∈S, a*e=e*a=a.

The identity element as identified in kernel is "0," which is used to indicate a note not to be played. "0" in this case is appropriate because measures are completed by adding notes, and it is consistent with the Boolean function, which is represented through activation (1) or inactivation (0).

Activation is perceived in the actual music-making and dancing of the *tiniglalaki.* Kernel is identified through the presence of "rest" or the inactivation when the action to play music or to dance is paused. This is a temporary rest, awaiting a continuation. In these two contrasting elements: action and inaction, the factor of rest has a property that is similar to a kernel. When any active note is assigned in the area of rest, as long as it has the same or less duration, it is accommodated by the rest region and it retains its identity.

Purposes of the Research

The thrust of this study is to 1) foreground the mathematical concept and application of kernel to music through the analysis of *tiniglalaki;* 2) establish the character of the *tiniglalaki* through the connection of kernel to musical notes so as to understand the synchronization between music and dance; and 3) inform educators and readers, in general, the findings from analyzing ethnographic data that are relevant for Applied Mathematics.

The study is important in enriching the local materials of education, particularly in support of the current "contextualization" program of the Philippine government. Also, it can recognize the Panay Bukidnon elders who have given their informed consent in 2005, permitting the researcher to conduct the interview, observe, and play their drum and gong, for the dissemination of indigenous knowledge and its inclusion in the country's educational system.

Methodology

A mixed methodology has been employed in this study. The quantitative method has examined sequences of notes based on the concept of kernel (Bloch, 1987). I looked at this concept in *tiniglalaki* music not just as a presence of silence or the absence of sound but how it provided for an effective performance through keen attention of finding ways to synchronize their music with dancers' movements. The research also examined the 'waiting time' of performers before their actions are made to produce sound. Through the intervals of sound and silences, their sequences, and preparation to play the instruments, I explained the formation of a rhythmic pattern that helped in the coordination of different instruments.

On the other hand, my qualitative approach was conducted through ethnography. Specifically, the fieldwork was done in 2005 in the highlands of Panay, particularly in Barangay Garangan of Calinog, located in the northern portion of Iloilo, Philippines. In the recording of the music, I transcribed the sound in the form of music notation. This transcription aids in mathematically representing the kernel. The music notation of gong and bamboo instruments serves a concrete representation to analyze the *tiniglalaki.* This notation allows the visual evaluation on the existence of kernel and its bearing on *tiniglalaki.* The first procedure that the researcher undertook was to listen and examine keenly an audio recording. Within the music notation, there are elements of pitch, or levels of frequency, degree of loudness or softness, duration of notes, and timbre, or quality of sound. The mathematical analysis is based on these elements: the interval (distance) between notes within a measure and the duration of played notes. In this study, a number value represented the length of played note or the notes that are not to be played. These values are mapped into a mathematical function.

Findings

The analysis is divided into two parts: the Introduction and the Loop part. It is observed that there are instruments that make up the music. The Panay Bukidnon call their bossed gong as "*agung*". There are two types of beating this instrument: using a pair of sticks (each has around ½ inch width) on the rim of the gong; this is called "*patik*".

In the notation below, there is a part where the music repeats over and over again. This part is identified by the heavy double bars starting from the third measure. These repeating measures are introduced by an introductory measure. There are three introductory measures and five repeating measures.

On the other hand, when the agung is played using a padded beater on the gong's boss, this is called "*kadul*". Two types of indefinite pitches can be heard: a low tone when both strings are damped by tightening the grip on the strings near the gong's rim. In contrast, a relatively higher tone is heard once it is played openly.

Figure 3. Patik, or use of sticks, on the rim side of the gong.

Figure 4. The playing of kadul, or using padded beater on the embossed area of the gong supports the rhythmic pattern of the patik.

Figure 5. The tambur is a two-headed drum and in this photo, the upper head is the one beaten. The Panay Bukidnon believe that the lower head resonates when the upper head is beaten.

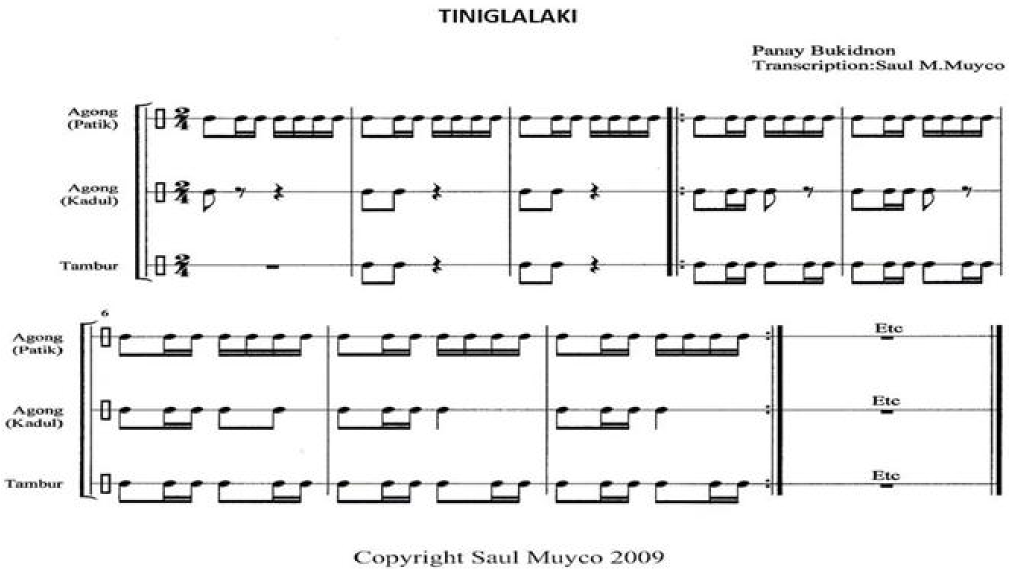

Figure 6. A transcription of my field recording taken during fieldwork.

On the other hand, the *tambur* complements the *agung* in its two types of sound production, the *patik* and *kadul.*

Mathematical Representation

The mathematical analyses are based on the playing of patik on *agung, kadul* on *agung,* and the beating on the *tambur*. These are seen in the eight measures of my example. Each instrument is represented by a sequence.

The main interval used for this study include the 'half close-half open interval'. The interval shows that the emphasis of notes is at the beginning and paves the way for the next measure. Notes that are represented as half close-half open interval shows that striking an instrument starts at the beginning and fades in its duration. Open interval is as well used to represent sound waves after the player hits on the instrument, or is playing a note. There is then an interval before the next note. Sound duration is represented with integer values. Although real number is the appropriate representation for the notes because music is by nature time related and is continuous, western notation confines the values in integer form. The choice in representing the options whether notes are played or not is a simultaneous function, which can present the choice of independent variable value.

Simultaneous function can present the function based on the choices of independent variable. The independent variable here is the choice of the composer to use the note for the measure or let it stay as rest.

Music is divided into measures for uniformity and observance of breathing. I notated *tiniglalaki* with the time signature of 2/4 (not as a fraction though but as a representation of a note value over number of beats in a measure). This notation implies that each measure can have eight counts. A measure is represented mathematically as,

$$\bigcup_{1\le j<k}^{8} [j,k) \qquad \text{Equation (3)}$$

There are two concepts used here. The measure count, which is eight for every measure; that is, $|M_i|=8$. Another concept is the position for the note; that is, 1st…8th. This notation appears as values for j and k in [j,k).

If $|\bigcup_{1\le j<k}^{8}[j,k)|<8$ then there is a kernel that completes the position set |{1, ..,8}| to count 8, and the possible kernel is [min{ positions unoccupied}, max{ positions unoccupied}).

Sequence Representation

The music of each instrument is composed of measures. These measures are grouped as Introductory part and Loop part. Therefore, the sequence representation for each instrument is,

$$\bigcup_{t=1}^{3}\bigcup_{1\le j<k}^{8}[j,k)_t \; + \; \langle \bigcup_{t=4}^{5}\bigcup_{1\le j<k}^{8}[j,k)_t \rangle$$

Tabular Representation

To identify the kernel and determine its impact on the *tiniglalaki* music, it would help to see the music in a tabular form. The table below (Tables 1.1 to 1.8) shows the duration of notes for the instrument-playing called *patik* (P) and *kadul* (K) on the *agung*; also the use of *tambur* (T). The blank space represents the duration of sound occupied by the note starting from the position at the left. It likewise shows the eight counts as outlined above and the total of eight counts at the right side. The kernel is shown in the table. The density is determined by comparing the number of played /not played notes to the total count for the measure with three instruments.

Table 1.1.

Kernel on the First Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		6						8
T	8								8

Density: 10/24 Kernel Density: 14/24

Table 1.2.

Kernel on the Second Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		2		4				8
T	2		2		4				8

Density: 16/24 kernel Density: 8/24

Table 1.3.

Kernel on the Third Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		2		4				8
T	2		2		4				8

Density: 16/24 Kernel Density: 8/24

Table 1.4.

Kernel on the Fourth Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		1	1	2		2		8
T	2		1	1	2		1	1	8

Density: 22/24 Kernel Density: 2/24

Table 1.5.
Kernel on the Fifth Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		1	1	2		2		8
T	2		1	1	2		1	1	8

Density: 22/24 Kernel Density: 2/24

Table 1.6.
Kernel on the Sixth Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		1	1	2		2		8
T	2		1	1	2		1	1	8

Density: 1 Kernel Density: 0

Table 1.7.
Kernel on the Seventh Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		1	1	4				8
T	2		1	1	2		1	1	8

Density: 1 Kernel Density: 0

Table 1.8.
Kernel on the Eight Measure

	1	2	3	4	5	6	7	8	
P	2		1	1	1	1	1	1	8
K	2		1	1	4				8
T	2		1	1	2		1	1	8

Density: 1 Kernel Density: 0

The kernel(s) identified in this music are:

Table 2.1.
Kernel in the Introductory Group of Measures

INSTRUMENTS	KERNEL
AGUNG (PATIK)	None
AGUNG (KADUL)	[ker[3, 8))$_1$, [ker[5, 8))$_2$, [ker[5, 8))$_3$
TAMBUR	[ker[1, 8))$_1$, [ker[5, 8))$_2$, [ker[5, 8))$_3$

Table 2.1. Kernel in the Loop Group of Measures

INSTRUMENTS	KERNEL
AGUNG (PATIK)	None
AGUNG (KADUL)	[ker[7, 8))$_4$, [ker[7, 8))$_5$
TAMBUR	None

Based on Tables 2.1 and 2.2, the kernels identified for *agung (patik)* are none. For *agung (kadul)* there are five, with count six on third position of the first measure, four on the fifth position of the second measure, four on the fifth position of the third measure, two on the seventh of the fourth measure, and two on the seventh of the fifth measure. For *tambur*, there are three, with count eight on the first position of the first measure, four on the fifth of the second measure, and four on the fifth of the third measure. The longest kernel found is on the 8th count, followed by the 6th, then 4th and then 2nd.

Density Measures

The ratio of the kernel density to notes is determined by comparing the count of kernel over the total count in a measure to the count of notes over the total count in a measure with three modes of instrument-playing.

Table 3 shows that kernel ratio decreases from 58 to 33 from measure 1 to measure 3 in the introductory measure. In the loop measure, it shows that the highlight of the loop measure and the whole music for that matter is in the fifth where kernel ceases

Table 3.

Ratio of Kernel in the Introductory and Loop Group of Measures

	Introductory				Loop			
Measure	1	2	3	4	5	6	7	8
Ratio	58:42	33:67	33:67	8:92	8:92	0:100	0:100	0:100
Total		42:58				3:97		
				18:82				

to exist. Comparing the introductory part to the loop part, the kernel in the introductory part has more kernel density than the loop part. Over all, the count for kernel is 18% less than the played note which is 82% .

The Uniqueness of Property identified with the Kernel

The kernel serves as an identity element that assumes the character of the notes. It replaces the place of notes. But in addition, it serves as a cumulative space for kernel occupying more than one count. The notes that can replace kernel of count |ker[j, k)|>1 are note/notes with count 0<|[j, k)|<7. If notes replacing the space for the kernel is less than its space then another kernel must complete the remaining space. Thus, if kernel count is |ker[j,k)|=n and note count is |[j,k-h)|<n then ker[j,k) will be replaced by [j, k-h) and ker[k-h, k).

This indicates that in place of a kernel there are numerous possible note combinations that can be applied. This possible combination of notes available in kernel's place caters for the intuition of the particular group driven to represent its culture.

The Bearing of Kernel on Music

The longest kernel range is found in the first measure and it is found in the tambur part. The *agung (patik)* has no kernel in the first measure. This finding implies that before the play of *tambur* and the *agung (kadul),* the *agung (patik*) initiated the lead on the sequence of the rhythmic pattern that has served as a margin guide or cue. This is an important role for the *agung (patik).* Among the different instruments, only the *agung (patik)* did not have a kernel as it provides the structural basis for other instruments' playing of the *tiniglalaki.*

Figure 7 demonstrates that the arrangement of musical instruments (*agung patik, agung kadul,* and *tambur*) in terms of

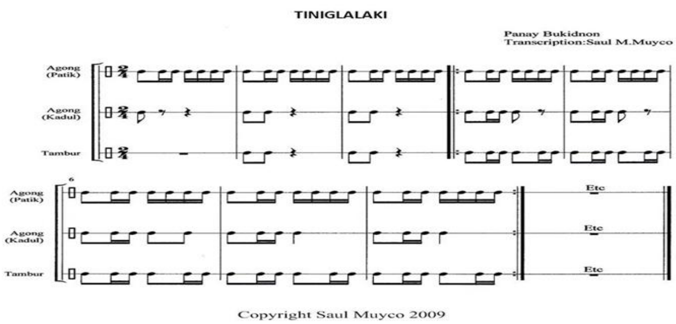

Figure 7. The repeated rhythm is shown being played by the agung (patik) while the other two instruments enter on strong beats, usually in a two-note pattern.

order does not change in all measures. This sequence manifests that it is the template measure that maintains its originality. The next longest kernel count is 6, which is found in the kadul in the first measure. It shows that the play of *tiniglalaki* starts from a thinner to a more robust sound instrument (tambur).

The uniqueness of *tiniglalaki* music is in its timing including the timing of the kernel. The density of the kernel relative to the notes decreases in ratio in the Introductory part (58:42 to 33:67). The changes in density confirms the direction of instruments that is elevating the mood of the dance in the Introductory part. On the Loop, it measures the lowest kernel density (which also means the highest note density). The direction proceeds from the first measure in the Loop part to the fifth measure and maintains a constant density up to the last measure (see Loop).

The density of the kernel in the introductory measure is more that the Loop part which shows the music is gradually increasing in intensity as it reaches the Loop part. This density gives an impression of heavy instrument playing at the beginning of the Loop measure. Such an emphasis in playing also enhances the presence of a downbeat that gives a sonic perception of an outright stress. However, a steady instrument playing follows and this aids in the regularity of the dance flow after the introductory part.

On Related Kernel

Earlier, kernel has been identified as a 'rest' between musical notes. This rest can be the silent part of a measure where notes are inactive. Such silence is considered as kernel because of its ability to take in any active note of the same duration or less to its place and grant its own identity. On another perspective, kernel can also be seen as a waiting time for the strike of the next note. Because instrument players need coordination to make their ensemble work, they also actively observe musical "cues" especially in the kernel region. On this view, kernel has an important role in the beauty of music as well as the movement of dancers because it is in the kernel where the expression in music and movement in dance is being conceived. The longer the waiting time (kernel) the more opportunity the instrument player or dancer can prepare for their next note or move respectively.

The Essential Kernel

Since time is continuous, the space between two notes prepare instrumentalists for the next strike. Within the concept of kernel is another idea of the "essential kernel". The essential kernel starts after the strict strike portion of note in the measure. Thus,

$$(j,k) \subset [j,k)$$

Essential kernel is a proper subset of a played note. It excludes j for it is the portion

Table 4.1

Essential Kernel in the Introductory Group of Measures

INSTRUMENTS	Measure 1	Measure 2	Measure 3
AGUNG (PATIK)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)
AGUNG (KADUL)	(1,3)	(1,3),(3,5)	(1,3),(3,5)
TAMBUR		(1,3),(3,5)	(1,3),(3,5)

where the note is struck. Essentially the strike of the note hits only at j, the area after j up to k no matter how small is just a sound wave from j and is where the instrumentalist prepare for the play of the next note.

Similarly, the space before the first note of the music of the instruments can also be a waiting time. This space is conceived as an initial kernel.

(0,j) <[j,k)

Initial Kernel

The initial kernel appears on the instruments at the beginning of the music and at the end of the measure. Tambur has an initial kernel in the introductory measures. The agung kadul has an initial Kernel in all measures. However, the agung (patik) has an initial kernel only at the beginning.

Table 4.2

Essential Kernel in the Loop Group of Measures

INSTRUMENTS	Measure 4	Measure 5	Measure 6
AGUNG (PATIK)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)
AGUNG (KADUL)	(1, 3), (3, 4), (4, 5), (5, 7)	(1, 3), (3, 4), (4, 5), (5, 7)	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)
TAMBUR	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)

INSTRUMENT-PLAYING	Measure 7	Measure 8
AGUNG (PATIK)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)	(1, 3), (3, 4), (4, 5), (5, 6), (6,7), (7, 8)
AGUNG (KADUL)	(1, 3), (3, 4), (4, 5), (5, 8)	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)
TAMBUR	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)	(1, 3), (3, 4), (4, 5), (5, 7), (7,8)

Table 5.1

Initial Kernel in the Introductory Group of Measures

INSTRUMENT-PLAYING	PRE-MEASURE		
	1	2	3
AGUNG (PATIK)	(0, 1)		
AGUNG (KADUL)	(0, 1)	(0, 1)	(0, 1)
TAMBUR	(0, 1)	(0, 1)	(0, 1)

Table 5.2

Initial Kernel in the Introductory Group of Measures

INSTRUMENT-PLAYING	PRE-MEASURE				
	4	5	6	7	8
AGUNG (PATIK)					
AGUNG (KADUL)	(0,1)	(0, 1)	(0, 1)	(0, 1)	(0, 1)
TAMBUR					

The Bearing of Related Kernel to the Music

The length of Essential Kernel as illustrated earlier are 4, 2 and 1. The related kernel with length 4 is found at the ending two measures of the *agung (kadul)* at the loop measures. This result means that the *agung (kadul)* prepares the other two instruments to start the loop measures again. The next longest Essential Kernel is 2, which is found at the beginning of all the measures. This Essential Kernel defines the measures and keeps the pacing of the dance.

The initial kernel indicates the preparation period before each measures. The initial kernel is found in all three instruments before the start of the music which shows coordination period for the instruments. In all measures, an initial kernel is found in *agung kadul* which shows giving of signal for the other instruments to move to the next measure. It also shows that the greatest number of initial kernel is at the introductory measures which exhibits that the play of instruments gradually increases in intensity. It also provides an opportunity to emphasize notes and to prepare for the loop measure.

Conclusion and Recommendation

The aim of foregrounding the mathematical concept and application of kernel to music has been achieved in many ways. Through the music analysis of *tiniglalaki*, I found shifts of density in gong and drum music that build the intensity of the dance itself. I established the character of the *tiniglalaki* through the connection of kernel to musical notes. This character has been observed, for instance, in the Introductory part of the music were many of the initial kernels are found. Such density manifests the way music progresses from the Introductory to the Loop part. With the huge portion of the music as kernel (almost 40%), it shows that a large portion of the music is found on preparation time before continuing, for instance, to the playing of the drum or the gong; or for the dancer to proceed to his or her next dance step.

It is realized in this study that "kernel", given that its presence as a space between notes and consecutively as preparation time for musicians, proves to be an important factor in the synchronization and flow of music and dance. More so, as exemplified in the realization of the Panay Bukidnons "*sibod*", kernel is culturally significant for group cohesion. The loop section, with repeated rhythmic patterns, provide for community members to continuously play music, dance, and groove in the excitement of partner dancers who may be able to form a relationship as a result of the binanog event.

Kernel in this study has indicated that waiting time in music is important. Identifying the kernel in the different aspects of a piece of music is a way to determine the space where preparation can be made in music-playing. Choices can also be made in critical moments of accompanying dance while being in a kernel region as there are times when dancers can make a mistake; kernel can provide the players to adjust the music on the dance steps of the dancers. This can be noticed in the set of notes that are played after the kernel's presence. There are observations in the study that needs attention. Notes played are not the only important component in this music. The time without played music is likewise important because it contributes in the formation of a rhythmic pattern composed of played and unplayed beats. In terms of preparation, this space prior to playing helps in the coordination of different instruments such as the gongs and drum. With right timing, musicians exercise their skills and discipline, which are foundations for a fruitful play of music. Kernel also underscores the importance of the performer's breathing sequence.

Figure 8. On extreme left, researcher and author Saul Muyco with his fiancé (now wife) Heroina Pedregosa during his fieldwork in 2005.

The limitations of this study about kernel and music lie on the very nature of ethnographic method. As the location of research is remote, there are places that cannot be easily reached. Though my research participants (interviewees Federico and Lucia Caballero) are important personalities in the Panay Bukidnon community, there are still other resource persons that may contribute more to my study. However, this limitation should not discredit the importance of this study as the initiative to foreground kernel using a cultural tradition is a pioneering work, as well.

The concept of Kernel and its application to music inform educators and readers that there is wealth in ethnographic data that are relevant for Applied Mathematics. That is why I recommend more studies on the factors that motivate the construct of music-dance aesthetics, where the act is contrasted, waited on, and prepared for. I believe that the impacts of kernel as analyzed in this study can be understood as a contribution to the discipline of Applied Mathematics.

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