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The Content-Validated Geometry Lessons in Islam Observed Brain-based Learning

Sherma O. Sappari[1], Florante P. Ibarra[2], Amirul Mukminin[3], Kasinyo Harto[4], Lenny Marzulina[5], Herri Mulyono[6], Asmendri Asmendri[7]
[1]Maharlika Elementary School, Manila
[2]College of Education, Central Luzon State University, Science City of Munoz, Nueva Ecija, Philippines, corresponding e-mail: fpibarra@clsu.edu.ph
[3]Faculty of Education, Universitas Jambi, Indonesia
[4,5] Universitas Islam Negeri Raden Fatah, Palembang, Indonesia
[6]University of Muhammadiyah Prof. Dr. Hamka, Jakarta, Indonesia
[7]Islamic State University of Mahmud Yunus, Batusangkar, Indonesia
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Abstract
This study examined the process of learning geometry in content-validated lessons with the integration of Islamic values as perceived to have observed brain-based learning principles. Anchored in a grounded theory, theoretical sampling was utilized among sixteen 4th and 5th grade students in geometry class including three teacher-observers and one teacher-demonstrator playing the "emic-etic" role or participant observer. Lessons in geometry with Islamic contexts were sporadically presented with citations of verses from the Holy Qur'an coupled with Islamic value-infusions. Designed in a qualitative grounded theory approach, an interview script was used for individual and focus group interviews. Ten content validated -lessons in geometry were designed to capture the Islamized learning phenomenon wherein field notes of observations and video footages were qualitatively analyzed using the lens of systematic approach coined as constant comparative method of analysis. Results indicated that substantive theory on the process of learning geometry in content-validated lessons with Islamic value-infusions as perceived to have brain-based learning was evidently observed which revolved on five sub-elements: (a) connection; (b) attention;(c) imagination and action; (d) emotions and recollection; and (e) associations. The approach to integrating Islamic values in content-validated lessons recognized the presence and the process of brain-based learning principles. Observed in cyclical context, emotion and memory play a significant role to learning guided by the content-validated lessons in geometry. The infusion of religious values and appreciation of creation informs one's understanding of the emotions and their importance for learning which are therefore critical to brain-based learning principles.

Keywords: brain-based learning, content-validated lessons, emotions and memory, imaginative learning, malleable memories and associations

1. Introduction

Learning is pragmatic in content validated lessons in geometry. Sabutan (2008) argued that the essential purpose of classrooms, which is insufficiently articulated, is to highlight the integration of Islamic values in all aspects of academic concepts being learned by students. Thus, preparing lesson plans for teaching geometry and other school subjects from the Islamic point of view would be

imperative to achieving this vision like offering an avenue to clearly articulate the process being emphasized in this study.

Furthermore, several empirical studies have been conducted relative to brain-based learning principles in the context of education (Suarsana, 2018), education and science (Rowlands, 2014; Saravani, et.al, 2016; Triana & Bahrun, 2019), potentials of brain-based learning (Gozuvesil & Dikici, 2014), and functions of brain in teaching and learning (ElAdl & Saad, 2019). The theory that is based on the structure and function of the brain is Brain Based Learning theory (Kaya, 2012). As long as the brain is not prohibited from fulfilling its normal processes, learning will occur (Triana & Bahrun, 2019; Suarsana, 2018). People often say that everyone can learn. Yet the reality is that everyone does learn. Brain-Based Education is the purposeful engagement of strategies that apply to how our brain works in the context of education (Rowlands, 2014).

Conversely, in the context of defining functions on Islamization effort, the structural principles of practitioners' task would be essential to those working in the field such as educational leaders and teachers and how to transmit these concepts through numerical approach which requires such process (Habibi et al., 2018; Muazza et al., 2018; Muazza et al., 2019; Mukminin et al., 2019; Widana et al., 2023). Sappari (2006) argued that "Muslim learners would not be learning best when Islamic values are not fused in the lesson" (p.23). To clearly establish the defining functions and to address the pressing issues on insufficient Islamized approach, there have been numerous efforts directed towards the inclusion of Islamic elements to all courses in a national capacity (Chaiklin, 2015; Sabutan, 2008; Safi, 1993; Sappari, 2006). For instance, the implementation of the Deped Order No. 51, s. 2004 marked the mainstreaming of Madrasah education in the Philippines. This unique curriculum aims to establish Islamic schools that would prepare generations of learned Muslims imbued with Islamic values who are spiritually prepared to serve the people and the country as a whole (Mukminin, 2022). It also aims to unify the long history of dichotomy among Muslims, promote Filipino national identity, and at the same time preserve the Muslim cultural heritage.

Given these scholarly observations on brain-based learning and despite much deliberation and discourse in Islamic context, much work on the *process* of how brain-based learning is observed in Islamic context remains unclear which provides an avenue for clarification. To further capture this missing link, we conceptualized lessons in geometry with Islamic contexts and presented each topic to students with citations of the verses from the Holy Qur'an, including citations of Muslim mathematicians and their work in the field, as well as values attached to it such as appreciation of the creation, value of qualities, and compliance to certain religious obligations, all are embedded in each lesson being presented.

We, the researchers, believed that infusing Islam in teaching geometry would create a better individual who should possess both the good qualities of the mind and the spirit. As constantly observed in a Muslim geometry class, students tend to associate geometric shapes to something that represents religious idea, a dominant characteristic of a grade-school Muslim learner. Thus, learning geometry in this context should reflect the belief in the Creator as the source of knowledge. More so, the infusion of Islamic fundamentals to numerical concepts would be an avenue for academic discourse. It is in this premise that the study hoped to address how the *process* of brain-based learning in Islamic context is observed. The teaching and learning experiences discussed in this study would provide educational leaders and administrators in revisiting their school's mission, vision, and goals in teaching numeracy as two-fold but single scope that is academic and religious.

Moreover, we vividly expressed our interest and passion in the research topic since teachers both in the elementary and secondary schools in the Philippines face a constantly growing concern and challenge on teaching methodology for students involving Muslim learners, considering the demands in the increasing role of teachers in understanding the nature of the learners with diverse cultural and religious backgrounds. Muslims in the school community believed that infusing Islam in teaching geometry would create a better individual who should possess both the good qualities of the mind and the spirit. Therefore, the purpose of this grounded theory study is to give emphasis and articulate how the specific *process* occurs in a brain-based learning observed in Islamic context.

2. Review of related literature

2.1. Teaching geometry with Islamized Context

Numerous studies on teaching geometry within Islamic contexts have been chronicled in terms of secular education and Islam (Gesink, 2014; Chaiklin, 2015; Hariastuti, et al. 2022) and teaching history in geometry (Clark, 2014; Fried, 2014; Reay, 2015; Randewijk et al.,2022). Geometry, as a field in mathematics, was a practical space knowledge that deals with shapes, angles, dimensions and variety of things everyone sees in everyday life. Gesink (2014) accentuated the premise for Muslim students of having knowledge of the Holy Qur'an and observance of its pillars, the passing of day and night in order to observe daily prayers at a fixed period and affirmation of the oneness of God, are some of the motivation that geometry and other branches of mathematics evolved from these religious practices. More so, as highlighted in Chaiklin (2014), mathematics such as geometry and other mathematical fields play significant part in the lives of Muslim which should not be disregarded in order to achieve the aim of making a holistic Muslim learner guided by the teaching and learning principles. Specifically, the pedagogical approach to teaching geometry centers on identifying shapes that morel likely reflects structures associated with Muslim churches and other related structures.

The Islamization efforts after First World Conference in Mekkah in 1977 created the avenue to reflect in putting Islamic contexts in all fields and disciplines in general and geometry in particular (Clark, 2014). For geometry lessons to be Islamized, Qur'anic verses, historical contributions of the Muslim mathematicians, and Islamic values such as appreciation of the creative power of Allah found in various shapes were fused, and constantly upheld these common approaches so that each lesson to be taught and learned would be aligned to Islamized goals (Fried, 2014; Sappari, 2006). These approaches, however, have conflicting view; firstly with the presence of the secular education, secondly, the use of history in teaching mathematics. Though, there are recent studies in the use of history of mathematics somewhat gaining appeal in teaching mathematics (Hariastuti et al., 2022; Mekarina et al., 2017; Randewijk et al., 2022; Reay, 2015). In the recent study conducted by Triana et al. (2023), the strategy of integrating Islamic values in mathematical learning can be done through infusion, analogy, narrative, and interpretation with an integration model between the Qur'an and math which can be briefly expressed as math from, for, as, to, and with al-Quran. Concurred with this context, researchers of this study designed teaching materials for Islamic value integration such as identification of figures and shapes which are have symbiotic relationships to religious teachings in Islam, formulated math problems reciprocal to Islamic values, and implemented Islamic values in the learning process through student active engagement in identifying representations of symbolic figures associated with Islamized contexts.

2.2 Integration of Islamic values in brain-based learning principles

Integrating Islamic values have been chronicled in the realm of brain-based learning mathematics (Kusno, 2022; Nurhamidah & Rosa, 2022; Sobarningsih, 2019; Suoroso, 2018; Triana et al., 2023). The very purpose of mathematics learning would be enhancing student thinking and reasoning skills to become skillful in solving math problems using numerical concepts. Kusno (2022) accentuated that math objects taught at schools probably intend to equip students to master numeracy and apply it in their daily lives, enhance their reasoning skills that would shape their personalities. With the context of learning mathematics, the purpose of integrating Islamic values would be assisting students to further boost reasoning, communication, connection-construction, and problem-solving skills that are embedded from the context of live and culturally Islam-based approach. Otherwise, the learning outputs among students would be worthless because the transmitted information is not connected to a specific representation built on daily cultural practice. Nurhamidah and Rosa (2022) emphasized the necessity of deigned mathematics activities that is integrated-learning approach with religious values in every lesson, specifically Islam, as essential part of the efforts to enhancing student Islamic identity and character. Infusing mathematics learning accorded with Islamic values can be done by incorporating school materials with religious information and target skill so that a strong substantive

theory would be formulated. Islam does not have dichotomy as Triana et al. (2023) highlighted because its religious identity pays great to teaching ang learning science including mathematics.

Learning the numerical concepts that has Islamic value infusion is defined to creating continuity amongst school-based math instructional materials and the embedded values taught in Islam. Similarly, mathematics can be practiced in one of the sciences taught in the Qu'ran by individual Muslim students. Conversely, Suoroso (2018) observed that internationalization of Islamic values in the academic context like learning mathematics in different educational institutions has not been optimally applied caused by insufficient model formulation and strategy of infusing Islamic values and mathematics that could be utilized as reference. Further, Sobarningsih et al., (2019) accentuated that integration between two contexts like mathematics learning ang Islamic values would not be a representation of a process to Islamize math, create Islamic math, or form religious math. This negotiation is done to mold student to be more religious by way of brain-based learning math. These empirical evidences on integrating Islamic values to brain-based learning principles in math aims at enhancing math identity a means for Muslim students to carry out the purpose of their creation.

Additionally, the field of neuroscience was a new discipline that requires empirical evidences which connect to brain-based learning in education. (Fried, 2014) This would allow the emerging discipline to create an avenue on how this process of brain-based learning would occur in the classroom. In Reay (2015), the idea of solving an academic task in the classroom is reflected on learner's capacity to get engaged on certain learning condition occurring in the brain. Thus, the need to implement the brain-based method is critical in educational setting.

These principles of making connections synthesize research related to the brain and learning from many disciplines and present it in a form that is useful to educators (Aldridge, 2015). The principles presented can function as a theoretical foundation for brain-based learning, and other guidelines and a framework for teaching and learning. These principles and the ideas generated from them come from a wide range of additional disciplines, including transmission and learning using memory to recall specific concept (Ibarra, 2017a, 2017b), the power of the brain to extract stored information that would define brain-based learning approach (Murphy et al., 2015), brain-based principles of retrieving mathematics concepts (Rowlands, 2014), brain-based approach to bilingual education (Mukminin et. Al, 2018) and process in creating learning concepts to empowering student brain-based learning efforts (Mekarina et al., 2022; Randewijk et al., 2022) .All of the principles are the result of a cross-disciplinary research. The principles intended to highlight brain-based learning framework for selecting the methodologies that will maximize learning and make teaching more effective and fulfilling. They may open doors for educators, increase teaching options, or serve as a guidepost to educators already working to implement brain-compatible teaching practices. Following brain learning principles, studies (Gozuvesil & Dikici, 2014; Suarna, et.al, 2018; Triana & Bahrun, 2018; Tang & YiYuan, 2019) highlighted the function of the brain to teaching and learning but insufficiently explored how brain is consciously and unconsciously interact between mathematics concepts and Islamic context.

We, the researchers, believe that the brain has an adaptive system which can be considered as a social brain. By way of its capacity to searching meanings, it occurs through pattering involving emotions which are vital components of patterning. Further, the researchers argue that the brain has the ability to perceive and create parts leading one's learning system through attention, involving conscious and unconscious processes within the learning process. These lead an individual brain to developmental and complex learning processes which are enhanced by struggles and challenges that made every brain as uniquely systematized.

3. Methods and materials

3.1 Research design of the study

This study utilized qualitative grounded theory research design in exploring the *process* of brain-based learning in Islamized content-validated lessons in geometry. Essentially, grounded theory is the attempt to derive theories from an analysis of patterns, themes, and common categories discovered in

observational data (Babbie, 2016). Moreover, it is a method of conducting qualitative research that focuses on creating conceptual frameworks or theories through building inductive analysis from the data (Bernard, 2006). Hence, the analytic categories are directly "grounded" in the data (Bryant &Charmaz, 2014). In this case, how the presentation these content-validated lessons in geometry was viewed and revealed the principles in the emerging brain-based learning. The method, grounded theory, according to Tie and Birks (2019) is gaining grounds in the application in education.

3.2 Data Collection and Analysis

The method favors interpretive analysis over description, fresh categories over preconceived ideas and extends theories, and systematically focused sequential information over large initial samples. This method is distinguished from others since it involves the researchers in data analysis while collecting data and used this data analysis to inform and shape further data collection. Thus, the sharp distinction between data collection and analysis phases of traditional research is intentionally blurred in grounded theory studies. (Bryant & Charmaz, 2014). Further, the "emic-etic' principles were applied to portraying two perspectives. The "etic" refers to objective or outsider accounts, and "emic" refer to subjective or insider accounts, of which the researchers became participants and observers when teaching the class.

We chose grounded theory as our methodology in this study and hoped to accentuate a specific process connected to the Islamic observed brain-based learning. Specifically, we sought to capture complex nature of teaching and learning geometry portraying two perspectives: the "emic-etic" principles. In "emic" perspective, we played the role as outsiders whereas in "etic", we became participant-observers in the teaching-learning process. Further, we showed how our content-validated lessons contribute to their learning (Zarges et al., 2018). Due to the value placed on participants and researchers' teaching and learning experiences, we relied on social constructivist grounded theory methods (Charmaz, 2014) to guide this study. We likewise considered the empirically derived definitions of observed brain-based learning espoused by scholars in this field (Caine & Caine, 2002; Kaya, 2012; Suarsana et al.,2018). Caine and Canine (2002) articulated brain-based learning as a process in the form of interconnection of neurons in the learning process, and new learning means new established connections between these neurons that define the process. Furthermore, Kaya (2012) defined the essential factors of brain-based learning as relaxed alertness, deep immersion and active processing. Considering the significant role and importance of mathematics conceptual understanding and the role of teachers in the implementation of brain-based learning as facilitators along the learning process and serving as mind map to facilitate students in understanding the concepts being learned (Suarsana et al., 2018, p.153). This study would be able to provide additional information to their definition by exploring the *process* of observed Islamic brain-based learning implicitly expressed in their views.

To address the research questions how students and teachers interact in the teaching and learning process and how the process of brain-based learning principles observed the content-validated lessons, we planned sequential topics based on the K-12 mathematics curriculum guide of the Department of Education in the Philippines. The topics in geometry was subdivided into seven content-validated lessons: symmetry, straight lines, triangle, polygons, circle, pie measure, solid figures. These concepts then targeted 4^{th} and 5^{th} grade students. In order to accommodate the topics in the new curriculum, they were slightly modified, while retaining the Islamic contexts in the concepts in geometry which is the central focus under study. For the 4^{th} grade lessons, we have integrated topics such as using the construction from a circle, lines, angles, triangles and quadrilaterals while all topics were introduced and discussed to 5^{th} grade students.

To select the participants, we have considered two types of sampling: student and teacher participants. Grounded theory study commonly begins with the criterion sampling such as "cases that meet some criterion" (Patton, 2002, p.243) was our point of reference. Due to the focus of examining the *process* of brain-based learning observed in Islamic content-validated lessons, we applied the theoretical sampling procedure. All participants both students and teachers were Muslims enrolled and

employed in a public Islamic school community. In this study, we have included a total number of 16 student-participants and six teacher-participants: eight students coming from 4th grade and another eight students from 5th grade, and three professional teacher demonstrators-observers. Professional teachers were categorized as licensed individual in the field of teaching. There were three mathematics teacher-observers for each grade level. Two teachers, one in 4th grade and the other one in 5th grade, demonstrated the lessons and played the role of participant-observers in all of these classes.

In our data gathering procedures, we have included individual interviews, focus group interviews, and ten teaching demonstration observations thru audio and video recordings (Bernard, 2006; Muazza et al., 2019). While individual interviews with students and teachers ranged between 40 minutes to an hour, all teaching demonstrations conformed with the Department of Education standards of 40-minute classroom discussion for each session. Using the interview script, teacher-observers were initially interviewed in order to refine the interview guide and reframe the questions. With this procedure, we had identified those questions that may fall out of the contexts of the topic being studied and simplify words that would uncover brain-based learning principles for teacher observer's use.

Data collection and analysis are cyclical (Bernard, 2006; Strauss & Corbin, 1998). While the first batch of 4 interviews was conducted, transcriptions were analyzed for emerging patterns and ideas. We continuously collected by adding additional batch of interviewees and analyzed data in a cycle through the transcripts. During the open and initial coding stage (Charmaz, 2006), we inductively coded the transcripts and broke them into individual excerpts. From these excerpts, we grouped them into codes. Once it was done, we went back to the field and collected more data. We used this procedure of theoretical sampling in order to capture all data that were necessary for this study. Defined by Glaser & Strauss (1967), theoretical sampling is a "process of collecting data for generating theory wherein the researchers jointly gather, code, and analyze data and decide what data to collect next in order to generate theory as it emerge" (p.45). We constantly observed after collecting new data and compared with the initial codes, we found some contradictions in the codes which offered us a space to restructure a more detailed coding system. Our initial sampling set the tone and theoretical sampling offered us direction where to go next (Charmaz, 2014). In the second stage, we group the codes together through axial coding. We selected similar concepts found in the open coding and looked for the axis that connects between codes together. After grouping codes into categories, we continued refining those codes and categories by means of constant comparative method of data analysis (Strauss & Corbin, 1990). After identifying a set of categories, we defined one more category which ties all these categories together through a process of selective coding (Charmaz, 2014). We made sure that each core category connects all codes together and used as basis for our final substantive theory. Thus, grounded theory is a process where data collection and analysis happen in a cycle, and in every cycle, the raw data takes a step closer towards becoming a theory.

After formulating the substantive theory through the analytical phases, we have utilized in the qualitative data, follow up interviews to participants provided an opportunity to confirm the meanings of the categories, their distinct relationships to one another, and the theoretical output as a whole. In the confirmatory procedures, some simply conformed with the categories while few reviewed and offered substantive commentaries. Upon reflecting from these feedbacks, the categories and their sub-elements were revisited, restructured, and further refined for its finality. Feedbacks on audio and video recordings were likewise revisited which helped us in reconstructing the components presented herein.

4. Results and Discussion

The substantive theory on the process of brain-based learning principles observed in Islamized content-validated lessons in geometry. The term substantive theory is a "particular theory that applies to a specific element of practice" (Merriam, 2009, p.200) is the output of grounded theory research design. A theory is imperative since it contains general notions in any field serving as fundamental

elements or in some cases justifications for specific facts or phenomenon that guide inquiry in a particular discipline. Figure 1 below illustrates the process and presence of brain-based learning that was observed in the classroom using the content-validated lessons. As illustrated in the figure, the model involves five semi-cyclical stages (with repetitions on the first two stages) emphasized as significant elements in the process (Charmaz, 2014). In its entirety, this process is cyclical and recurring in nature. First, the learner identifies a specific element that serves as link (*Connection*) from one point to another after which a symmetry of patterns emerged based on student own unique design (*Attention*). These two initial stages are constantly observed in cycle during the learning process. The learner then has the opportunity to further explore and make meaning of his learning experience by articulating what has been imagined and put into action (*Imagination and Action*). To be able to take a direct route to the brain under certain normal learning condition, the learner's ability to send signals from the brain through the cortex would deliver a more precise and rational response to a particular learning task. Repetition of this process strengthens retention thus enhances emotions and memory in doing tasks (*Emotion and Recollection*). The decision-making process (*Association*) can occur in the teaching and learning process. This can equip the learner to connect and identify something else in his mind and explain the significant relationships of all the interrelated constructs therein. Taken all together, the output is the formulation of learner's learning identity through a process (Observed brain-based learning in Islamized content-validated lessons).

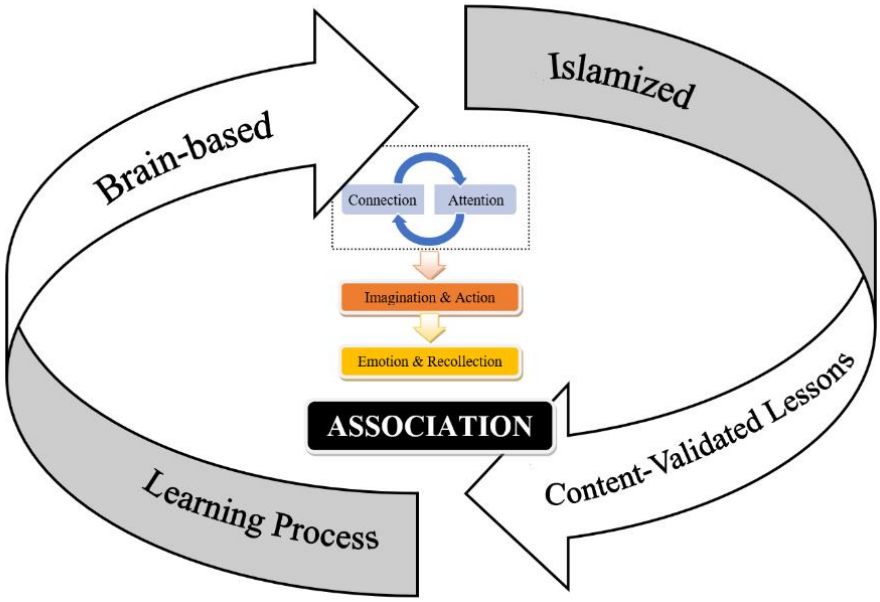

Figure 1. Substantive theory of brain-based learning process in Islamized content-validated lessons

4.1 Phase 1: Connection

First phase of the process: Connection through point is the beginning of constructions. This stage had been identified as the primary phase describing how students interact and participate in the teaching and learning process in Geometry class. The Grade 4 students constructed polygons using protractor and ruler. When asked how a student perceived a specific topic, Student A replied,

> "The point is important because the lines of the polygons started from point. Polygon will be useful for me as a Muslim, I can create what I want like house using polygons, I am happy because I learned that Math or polygon has connection with Allah's creation)."

The construction of lines, triangles, quadrilaterals found their origin from the construction of point from the center of the circle. These connected lines then can draw polygons such as triangles,

quadrilaterals. The manifestation of an action, object or thought (if it can be defined) necessitates a point of origin or departure, in relation both to manifestation itself and to the person who is conscious of its emergence. In the mind the point represents a unitary focus of conscious awareness: the physical world it represents a focal event in a field which was previously uninterrupted. Highlighted in Safi (1993) and Fried (2014), the point is exposed as a white spot functioning as symbolic figure for union and source. In terms of Geometry, it represents the center as the elusive controlling point of all forms. The result was in congruency with the findings of Schattschneider and Emmer (2003) stating that beginning from a dot on a paper, the students were tasked to create their own unique patterns, they did it by circling and rotating using protractor created a circle, from any side of the circle would be another point that would extend at exactly the same distance creating a line from the center to another center of the circle. In continuously creating circles, from the center created symmetrical patterns. These Islamic pattern designs reveal geometric proportions that served two objectives, firstly, in pattern design, proportions are strongly linked to geometry, which can be viewed as a self-guiding method of esthetically proven design. Secondly, Suarsana et al. (2018) accentuated geometric proportions regulate primarily the order of patterns; while at the same time they mediate between the two poles of order and diversity as well as among different esthetic level. It is constantly to be recalled that the spatial controlling factor of Islamic geometric patterns is symmetry – in which represented itself by the most fundamental numerical set that a given pattern can be equally folded into. Critchlow offered similar analogy that symmetry can be viewed as reflections of unity. Thus, the Islamic patterns reveal symmetrical language in geometry, equivocal on the evolution of equal distance which likewise observed in Abbas and Salman (1995).

These patterns can be seen in the mosque's domes, Muslims prayer of worship, as well as exists in God's creation that served as an inspiration as the students created their pattern designs. Further, Dabbour (2012) and Calle (2009) emphasized the inculcated appreciation on the value of point, unity of creation and the Oneness of Creator. the underlying relationship between cosmology and geometry is manifested in Islamic patterns where geometry acts as the vocabulary underpinning the pattern language and further support that geometry was independently discovered and applied by Islamic culture as a universal language.

4.2 Phase 2: Attention

Second phase of the process: Attention creates learning and connection. The symmetry of patterns from the center of a circle is a repetitive endeavor that is enjoyable after coming up with the students' own unique design. The idea that it stems from a drop of water as stated in the Holy Qur'an (76:2) *"Verily, We have created man from a drop of mingled fluid",* created connection to the students as a Muslim. Further, instructing that these designs ornate the place of worship, Mosque, geared their interests to individualize their work. Teacher Observer – 1 witnessed how attention in the Grade 4 class took place, as she described,

> "I observed how you [teacher] get student attention, it's there, in your motivation part where you start saying that Geometry or polygon starts with a point and such is also associated with creation, the creation of Allah which is Islamic values".

Using the protractor with pen and ruler sustained their focus and interest in the activity in order to provided and the activity has caught the attention of the students and sustained them throughout, again emerged from the contexts understanding that all created started from a point. One student observed to have started being himself and was asked by the teacher what was his 'secret' in doing so, he replied, *'point'*. The other students followed through in constructing.

Paying attention is essential to brain plasticity. Paying close attention is necessary for long-term plasticity changes. The notion of paying attention has always been important by teachers. Now neuroscientists are beginning to explain why it is so vital for learners as McNeil (2009) described by showing how patterns of neurons develop from attention and becoming stronger with use. Evidence

shows that focused attention helps pupils to gain more from their learning experiences, and that simple exercises can lead to learning improvements.

4.3 Phase 3: Imagination and action

Third phase of the process: The symbiotic relationship of imagination and action has similar outputs in brain-based teaching and learning process. As the students pay attention some 4th grade students articulated that they also use their imagination in coming up with desired figure in their mind, unique designs were achieved. When asked about the learning activity, Student 4-1 replied,

> "In sketching a polygon, I am thinking of what my teacher told me and I imagine that. I am using my imagination in a way I write the polygon, I imagine all the things my teacher mentioned on how I could do it".

Student 4-4 similarly emphasized his experience with the activity as he described,

> "The parts of my body that I used in our activity involve my hands to write, my eyes so that I could see, my ears and brain for imagination, I use my imagination so that I could think my perfect shape to write, I love imagining things, when I do the activity, I think of something first then write whatever my mind formulate inside my head".

The symbiotic output of student way to addressing such learning task evidently manifests on their accounts. Modified by diversification through imaginative interaction between geometric tasks and its symbolic figure formed inside student mind, a creative output is formed which defines student learning on certain activity. These particular findings from participants responses could be associated with the idea of McNiel (2009). The notion of plasticity then, embraces the fact that the neuronal circuits that are created by imagining are almost identical to those created by actual practice. Imagination and action have similar effects in the brain. Imagination by memory and learning through action likewise play vital role in the interdependent of brain-based learning process. The focus-group interviews occurred a week after the teaching demonstration, students have recalled the topics they have still remembered numerous names, they have even expounded how they have performed the activity given to them. The polygons, lines, angles, triangles, quadrilaterals were the topics named by the Grade 4 students in a focused-group interview. They used the words like *natatandaan* (remembered) and named the *paksa* (topics) or *tungkol sa mga paksa* (about the topics), and even similar terms like *natutunan, napag-aralan,* or *natuto* (learned) and *ginawa* (did). Below were the responses when they have related the experiences as they described:

> *"*Our lesson yesterday was about polygons". Student 4-1.
> "I learned last week how to create a polygon using a compass". Student 4-2.
> "What I remember is about the polygon and how to use the compass". Student 4-3.
> "We've learned the polygons last week and we also learned to use compass and I feel happy". Student 4-4.

Furthermore, 5th Grade students mentioned point, triangles and its types, quadrilaterals, sides, vertex, base, Mathematician Al-Khasi, pyramid and its types, radius, and cubes were the topics they have learned. One student explained:

> "I remember our topic last week was about Mathematics, all the dots and the creations of Allah start with the dot. Then the point, yes the point. We also made pyramids, the various types of triangles, and the equilateral and quadrilateral, isosceles triangle, and scalene triangle. Even about cubes and the sides, bases and others". Student 5-7.

When asked what topic they remembered and how they accomplished their tasks, students 4 and 5 shared their learning experiences,

> "I remember we made drawings on a paper, we created points and circles, then we drew pyramids, like triangles and even squares, and cubes also and many more, I remember all these things we did in class". Student 5-4.

> "What I still recall from our previous lessons in Mathematics was about a mathematician whose name is Al-Khashi. Then we did pyramids, the cubes, triangles then squares, then all things that Allah did started from a point. We also made circle then radius, and base vertex sides". Student 5-5.

Teacher-observer 2 recalled when asked about the teaching and learning process in the context of imaging a math concept that is put into action which resulted dimensional learning transformation. She explained:

> "I noticed when you [the teacher] constructed different designs from the point, then you constructed circle, then you constructed various designs of circles, after that you related it with different designs commonly present in a mosque, about how a certain figure is used in a mosque, you've introduced that how it is formulated. It is similar to that idea, just like that, because you defined the Pi by means of the ratio of the circumference and diameter of the circle. Yes. Then they [students] were able to come up with the value which is 3, similar to that context. Yes, correct. It is like you have introduced then an Islamic mathematician, and asked them the concept and importance of praying on time, that led them to discover the answer which is 3." Teacher-observer 2.

The findings on memory and learning could be associated with Triana et. al (2019) that remembering something could lead to positive learning output that defines various forms of emotions. Triana et. al espoused the idea how one can make sense of emotions by identifying them with the intention to act and noting their increasing levels of complexity. This is not surprising, for as many writers' point out the word 'emotion' means a spatial movement outwards. Furthermore, Teacher Observer 3 observed this elemental structure in the lesson, she explained:

> "They [students] are more interested when I enter the class, they are excited what activity would the teacher give them especially when they see things, so they become interested in the topic. In Math class, they are more becoming interested when giving them manipulative devises, things or any objects that they can touch, because that is how students would remember the topic, through their association with manipulative device or objects, they can easily relate their learning experience." Teacher-observer 3.

Thus, action is very closely connected with motivation, which as Gozuvesil and Dikici (2014) noted the course that draws feeling to action which is dependent on how considerable amount of vigor and attention an individual learner's brain and physical body exposed to a given stimulus. Implicit memory is composed of encountered actions and experiences in one's initial milieu and reflects how one is thought of and spoken to as product of such relationships. Conversely, explicit memory encrypts truthful information like names, faces, and places – the types of things everyone needs to recall deliberately. Implicit memory is not a solitary memory scheme, but an assemblage of processes connecting various brain systems that lie deep within one's mind. McNeil (2009) has found empirical supports that students who believe that intelligence is plastic or incremental, and that it can be enhanced, and perform learning tasks better.

4.4 Phase 4: Emotion and recollection

Fourth phase of the process: Emotions and recollection play significant role to learning. Majority of the student participants enjoyed the class as they have described it in a word *masaya* (happy). Even the three teacher-observers expressed their appreciation on the integration of Islamic teachings within the realm of Geometry. In reference with emotions and memory in Islamic learning context, Sabutan (2008) distinctively outlined the primary context of emotions, as confirmed by biologists and neuroscientists, consist the elements of amazement, gladness, annoyance, anxiety, repulsion, and despondency. Sabutan asserted that these basic primary emotions constitute distinct characters of adaptive behaviors crucial to survival. Scientifically speaking, it is still the case that the amygdaloid nucleus plays pivotal role on the cortex than the other way around. This tiny particle has the ability to take a direct route to the brain under certain normal learning conditions and signals are sent through the cortex delivering a more precise and rational response to a particular learning task. When asked how student emotion and memory contribute to their learnings, student participants described:

> "I feel so glad and I will be sharing these things I learned to those who were not able to attend the class today". Student 4-1.

> "I am so excited and happy because I learned something new about polygons, I always remember when I did my task, I was so happy when I got the right answer, I was a little bit annoyed if I hardly get it right". Student 4-2.

> "I feel amazed as I learned math and polygons, they have connections to Allah's creations. I feel sad at first but when I learned it gradually, I feel excited and happy because I can also teach this to my siblings". Student 4-4.

> "I enjoyed the activity because I learned how dots are connected in a polygon, I am embarrassed when making mistake at first, but I enjoyed much as I think of the possible ways, because I remember this activity". *Student 4-5.*

Furthermore, findings likewise highlighted teacher observers' words in order to describe the teaching and learning environment they have experienced. Teacher-observer 2 get connected with the lesson and express her liked on it on that day, she described:

> "I like most really is the concept of geometry, the point, yes the point, because we always tell our students the point is the start from one point to another. As if we are telling our students that everything comes for Allah, something like that. Another thing is, what I like most is, how students discover the point of reference, because through that they become aware to pray at certain period of time, not only being a Muslim or Islam that everyone needs to be aware of praying at certain time, I think any religious group must be aware to pray at certain moment in time." Teacher-observer 2.

She likewise vividly elaborated when asked how memory and emotions among her students contribute to achieving classroom methodologies, she further explained:

> "Actually, geometry concepts like what I've mentioned are really good for Muslim students, instead of teaching Islamic values separately, I can relate and integrate Islamic lessons to geometrical shapes or figures, yes, it is something like that. So, we concentrate not only on computational skills but, we must include emotions, very light classroom atmosphere, just like that. So that we could easily transmit the math concept to our students. Of course, when students see number figures at first sight, they would be shocked, however because you [as teacher] are able to conceptualize and integrate to Islamic values or lessons, it is good, the

> lesson becomes lighter and easier to handle, and not that harsh or difficult for them." Teacher-observer 2.

There are four guiding principles that inform our understanding of the emotions and their importance for learning. First, motivation is the driving power that links the emotions and actions. Second, the emotions are essential to all communication. Third, sense of touch is imperative for corporeal and expressive growth. Lastly, movement is intensely associated with emotion. To aptly put, a follow-up question was made to clarify her statements about the word *light* and *harsh*. This would further explain another principle about creating a good environment:

> "Because I am a Math teacher, when I teach the concept specifically the circle, right? I also introduce how to, like for example Pi, the ratio of the circumference of any circle to the diameter, how to get the value of it, just like driving the formula on how to get the value. In my case, when I teach geometry, I go directly to the point, oh this is it, range of circumference and like that. Because I can integrate it to Islamic values, I feel like it is no longer that hard for my students to understand, yes something like that. When I interpret a specific concept, it is not like the typical Math approach to a lesson, I introduce immediate computation, hands on for students to easily absorb the topic being studied, that approach would give me a meaningful student output." Teacher Observer 2.

Thus, to this end, the malleable connections between emotions to memory learning more likely to be created. Concurred with ElAdl and Saad (2019), the notion of relaxed alertness and active processing of memory can provide distinctive outputs wherein the latter offers greater gains for student academic motivation. The output emerges some sort to understanding working memory that is put into action which is developed through training in brain-based learning. The more gains in working memory coupled with action would more likely enhance the academic learnings of students.

4.5 Phase 5: Associations

Fifth phase of the process: The process of association could also be linked with student learning experience by way of decision-making. Which was also confirmed by the students by saying that they will share the learning experiences they had. According to Jensen (2008) malleable memories and associations are strengthened by frequency, intensity and practice under varying conditions and contexts. Teacher-observer 2, mentioned that one student who expressed to have done his work fast who was joining contest had deepen the idea and related such observation, he stated:

> Teacher-observer 2: "Actually, if they [students] have an idea, if they are pretty sure of their answer on specific question, especiall Abdulaziz [student], because aside from he is inclined in art, we send him to art competitions, so he has profound perspectives and concepts when it comes to geometry, something like that, he constructs his answer very fast".

Individuals who perform at high levels in their discipline utilize specific kinds of memory process. Tang and Yi-yuan (2017) present compelling arguments not just for the inclusion of the arts in the curriculum, but for the integration as essential elements in connection with pupil's power of attention. They finely detailed the arguments on the importance of sensory experience, the sensory system which is the primary source through which the qualitative environment is experienced. It is the sensory experience which provides the brain with the basic resources of making sense of the world. This context was associated with the responses of Teacher-observers as they described:

> "They [students] value, they give importance to the creation of Allah through their imagination of Geometry, they start from there, the contextual Islamic values, these geometric figures they see, they try to associate with the works and creation of Allah. From there, I see the connection and they interpret those in connection with their lives as Muslim or their Islam

> religion, they associate that creation in their Math lesson about geometric figures". Teacher-observer 1.
>
> "For example, I am a Muslim student, and there had been an integration of Islamic values in the lesson from a specific concept, what happens in the lesson, even a small point or small shape, these are associated with the creation of Allah or Islam beliefs, so they are thankful of it. They are appreciative about figures they see because these are associated with their beliefs, and every shape must be valued". Teacher-observer 2.

Saravani et al. (2016) emphasized the significant role of long-life learning and contends that educational institutions should not only nurture children's intrinsic motivation at school but raising their innate awareness and capacity for learning as they function in society. Love of learning remains central to happiness if memories and association continue to be intact. This is certainly true in terms of keeping students' brains active and healthy.

The concept of malleable memories and associations could be more likely linked to emotions which are critical to patterning for various reasons which are connected to brain-based learning. Connection, association, relation and integration were words commonly used by the teacher observers in order to describe value to the relationships. For the teacher-observers, the concepts of thankfulness, appreciation and values are emotions connected with the understanding of creation and that all creation started from a point, just as how humans are created from a mingled fluid, weaved within Islamic belief. In their narratives, teacher observers connect the value of awareness in praying on time in sharing the life of a Muslim mathematician in his quest for measuring the Pi measure. Teacher-observer 1 described,

> "Students will value all Allah's creation, they would imagine that through Geometry, the contextual elements of Islamic values start from there, and they can associate that these geometric shapes and figures are all associated with the works of Allah." Teacher observer 1

Specifically, the context of connection, association, relation and integration which are present during the course of teaching and learning, these terminologies are implicitly integrated into their methodologies as teacher-observer 2 described the value of relationships. He elaborated,

> "For instance, in my class, my students already experienced integration of Islamic values within a particular geometric shape as their lessons, even a single point or dot they see in the discussion, they will automatically associate this with the creation of Allah. In this way, they become thankful of it. They become appreciative about any figures they would see because try to associate these with their beliefs." Teacher-observer 2.

He further elaborated the connection of content-validated lesson in Islamic context to his observation on students' response to certain learning stimulus. Teacher-observer 2 shared similar perspective as he described,

> "Because students can relate how sun circulates in an orbit by way of looking at a center point, they are also become aware that as Islam, praying on time suggested by the sun orbit, must be properly observed, and they are very aware of that practice." Teacher-observer 2.

Thus, students' emotional relation in creating the mosque designs which have been repeatedly mentioned in creating patterns to emotions.

5. Conclusion and Implication to Education

The approach to integrating Islamic content-validated lessons recognized the presence and the process of brain-based learning principles. Relationship and association play vital role in brain-based learning principles. The integration of Islamic contexts in learning geometry has relationship and association with Allah's creation. This is particularly in the lesson about constructing of polygons from the center of the circle, where all other constructions like triangles, and quadrilaterals as their topic at the moment would evolve from and creation of symmetrical designs. Value on infusion of Islamic teachings emerged as dominant teaching-learning process. This context dominantly manifested in prayer (Salah) being one of the five pillars of Islam which is mentioned many times in the Qur'an as an obligatory duty for every adult Muslim.

No attention means no learning since attention creates connection. The symmetry of patterns from the center of a circle is a repetitive endeavor that is enjoyable after coming up with the students' own unique design. Imagination requires attention, with that said, imagination and action have similar outputs. The notion of plasticity then, embraces the fact that the neuronal circuits that are created by imagining are almost identical to those created by actual practice.

Imagination and action have similar effects in the brain. Emotions and memory play significant role to emotions and learning guided by principles that inform ones understanding of the emotions and their importance for learning are critical to brain-based learning principles namely motivations, emotions, senses and physical movements. Searching for meaning of these principles occurs through association of patterning. The search for meaning is an innate talent among Muslim students that tends to establish sense of identity. Since every brain is uniquely organized, students tend to come up with their own unique designs have formed their imagination through their creativity and their capability to associate with wider perspective.

Finally, as any conclusions developed within the framework of grounded theory by scholars are suggestive, incomplete, and inconclusive (Creswell, 2003). Certain limitations from this study are well-recognized and considered for future in-depth investigation. Similar to other empirical qualitative reports, the outputs represent a small group of participants, in this case the Muslim students and teachers, and are not therefore the representative of the perspectives and feelings of the large if not the entire population in the field. Because of the modified approach to teaching and learning that is anchored on the roles of the participants and purpose of the lessons (in Islamic context), there had been a manifestation to think intentionally relative to overarching issues and meaning attached to the daily lessons. Furthermore, the scope of the lessons has been formulated mostly on the premise of intermediate elementary mathematical concepts. Two salient points would require further inquiries: Firstly, would the process that is being chronicled in this work look different when applied to a broader extent of participant engagements such as national contexts; and secondly, is the universally agreed process observed in Islamized brain-based learning principles possible or even desirable or acceptable. Future researchers might investigate deeper into these inquiries utilizing a larger pool and with participants coming from different sectors of the society.

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