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Journal of Applied Environmental and Biological Sciences (JAEBS) is a peer reviewed, open access international scientific journal dedicated for rapid publication of high quality original research articles as well as review articles in the all areas of Applied Environmental and Biological Sciences.

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Effectiveness of Rhyme & Rhythm through Blended Learning

Dr. Tariq Javed[1*], Miss Buraira[2], Professor Dr. Muhammad Aslam Asghar[3]

[1]SST, Federal Government Public School No 2 (Boys) Tariqabad, Rawalpindi, Punjab, Pakistan
[2]MPhil. Scholar, Humanities Department, COMSATS Institute of Information Technology, Islamabad, Pakistan
[3]Mohi-Ud-Din Islamic University, Nerian Sharif, AJK

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ABSTRACT

With the rapid growth of information communication technology (ICT), teaching and learning styles have been dramatically changed in the twenty first century. Now the teaching learning process can be enriched through collaboration and more access towards communication by using synchronous and asynchronous modes of blended learning to enhance students' quality of the academic achievement. Now the learners have placed their position as digital learners in this digital era. Distinctive learning, participation can be constructed through a mixture of innovative methodology and quality of education blended to gather. The focus of this study was to investigate the effect of rhyme and rhythm by using blended learning on the performance of young children. The research aimed to analyze the impact of rhymes on the vocabulary of students at primary level. The sample of the study was consisted of 14 students from Fazaia Inter College Nur Khan Rawalpindi. It was an experimental study. The control and experimental groups were framed for the research purpose to collect data. The researcher administered 15 poems from a kindergarten book in grade five. Pre-test and post-test was conducted from the sample. Pre-Test was conducted before teaching the students. Pre-Test was based on the current knowledge of the students. Post-Test was conducted after teaching the students for eight days. Post-Test was basically based on the new learning and knowledge of the students. The time duration of an experiment was eight days. The results of the present study were analyzed and showed that students find it interesting to study with rhymes. They can learn quickly and effectively through rhymes due to encouragement and motivation. Students showed improvement in their vocabulary at a very high percentage. It was found that the respondents showed an effective response to the poems taught with proper rhyme and rhythm through blended learning.
KEY WORDS: Blended Learning, Rhyme, Rhythm, ICT, Synchronous Mode, Asynchronous Mode

INTRODUCTION

In this digital era Information Communication Technology ICT has become the revolutionary change agent in the teaching learning process [1]. There is a strong linkage between ICT and the learning process at primary level [2] which promotes student-centered approach [3] and considered as an interactive and effective approach of the learning at primary level [4]. The idea that the first identification of learning problems in educational institution or kindergarten may lead to applicable early interventions and therefore minimize reading and orthography problems in class has excited analysis on this issue [5]. The enhancement of learners' satisfaction through adaptive learning system is essential towards the promotion of educational effectiveness [6]. The research throws light on the fact that students at primary level tend to learn more with the blend of rhyme and rhythm. Students feel comfortable in learning the poem as compared to prose because of the intonation, stress patterns, rhyme and rhythm in the poems. The research opens the gate for the new techniques and methods teachers can adapt to produce better results from students.

Awareness within the development of learning to scan has long been established as pioneer to the acquisition of the alphabetic principle—the understanding that letters of alphabet signify phonemes in speech. Throughout the history teachers have contemplated their students with rhymes. It is the fact worldwide known that rhymes and rhythms make information more steadfast. Language literacy is debatably the most important skill child will acquire during schooling. Intrinsic motivation among learners is created through the combination of rhymes and rhythms [7] that can be transformed into new medium of education. The proverb "music is the food of the soul". It expresses which cannot be expressed and it on which it is impossible to remain silent on. Music gives a soul to the universe and wings to the mind of young children, which can be possible through blended learning modes.

Corresponding Author: Dr. Tariq Javed, SST, Federal Government Public School No 2 (Boys) Tariqabad, Rawalpindi, Punjab, Pakistan. Email: tariqjavedmiu@gmail.com

There is always a link between rhythm and brain. Music plays a vital role in the life of people. Many primary level students how interest in learning with music. The students enjoy poems as compared to essays and regular curriculum. A child's mind is somehow associated with music. The child always makes connection between music and learning. If the child perceives something in the form of a poem, the child tends to learn it quickly and with less effort. The blend of music tends to develop interest of students in books [8].

STATEMENT OF PROBLEM

The researcher noticed in her surroundings that students are not interested in learning and memorizing at primary level. The teacher puts in a lot of efforts through regular classroom techniques in this regard. But the students do not find them interesting at all and fail to produce results. Students find it boring to listen to the reading in a monotone. The researcher wanted to know the impact of rhyme & rhythm on the learning of primary level children at Fazaia Schools Rawalpindi Cantt.

The researcher has conducted this research to interpret the difficulties of the students, they face while learning the lessons. Children take interest in the lessons of poem because of the blend of the rhyme and rhythm in the poems. Phonetics & Phonology has deep routed impacts on the learning of the children. It helps the children to absorb and learn the lessons quickly. Students tend to learn more with the help of rhyme and rhythm.

RESEARCH OBJECTIVES

The primary objectives of this study include:

i. To study the effectiveness of rhyme and rhythm through blended learning at primary level.
ii. To enable the students to enhance learning with the blend of rhyme and rhythm.

RESEARCH QUESTIONS

i. Has rhyme and rhythm shown any impact on the learning of the students?
ii. Is the learning of the students improved with rhyme and rhythm?

DELIMITATION

Due to time constrictions, this study was restricted to:

i. The Grade V students at Fazaia Inter College P.A.F Nur Khan Rawalpindi Cantt.
ii. The session of the students was 2017-18.

REVIEW OF RELATED LITERATURE

HISTORY OF RHYTHM & RHYME

"For thousands of years, knowledge was imparted from generation to generation through the medium of singing and chanting" Rhyme has assumed a critical part in enhancing our vocabulary through oral methods for learning. Stories and lyrics were sung by artists everywhere throughout the world. A considerable lot of these artists had extraordinary gadgets and their format includes epic stories and news to choral and reaction narrating [9]. A sequence of words that contain comparable sounds is called rhyme. For example, slow/ show/snow/glow/though/bow; Rhyme isn't just a reiteration however a conditioning of sounds. The decision of blending words to make a sort of melodic reiteration is as old as humankind. The adolescent of this age gathering might be heaps of years from antiquated man, however the choruses, repetitions and dancing games of presently are not much different from those of the ancient times. Rhyme has been called as the punctuation of music. As in the previous days, there is a genuine connecting amongst verse and enchantment, amongst verse and memory. Children begin with rhyme and beat; even before they can talk. The gadgets of poetry are continually being utilized as a part of every-day life. Children and tenant farmers as well as business people know the significance of verse and "apt alliteration's artful aid." Pavement symbols, cards in transports, ads in daily papers, bulletins on streets, declarations on radio and TV, demonstrate that rhyme dependably tap the mind more rapidly. Christmas, sympathies, and welcome cards are best when they are in rhyme. Indeed, even we compose long birthday wishes for our friends and family in verses to make them more powerful. This sort of imagination draws out the creativity in everybody. Indeed, even on the most profound level, verse is not really "rhyme without reason". Poetry runs all the way from childish "twinkle twinkle little star, how I wonder what you are" to Thomas Stearns Eliot's song "The love song of J. Alfred Prufrock". When we need to express something or when we are profoundly incited, and when our feelings move over into a football cheer, we pen down them as ballad, or an adoration verse. A lyric communicates our internal feelings, celebrates our satisfaction, eases our pain and facilitates our torment. Due to its emphatically underlined beat and its capacity to convey forceful feelings, verse is the most

instructing type of discourse. Rhyme isn't just a help to memory, as we have learned in nursery rhymes and sayings, yet it is additionally a joy to the ear [10].

BENEFITS OF TEACHING RHYTHM & RHYME

Teaching rhyme to understudies is imperative since it begins with; a social affair of examination has demonstrated a relationship among rhyming dominance and possible perusing status. It isn't important that each child is a rhyming machine from the beginning. On the off chance that your kid isn't occupied with rhymes then it doesn't imply that the youngster will be a poor understudy when the kid gets senior. It just implies that you can coordinate additionally rhyming occasions into their opportunity. Rhyming aids kids recuperate their oral phonetic aptitudes when all is said in done. Rhyming encourages the understudies to energetically work their verbal aptitudes, which extends them a sort of "approval" to work dialect in different ways. Phonemic awareness puts the reason for composed dialect. Rhyming is a harbinger to figuring out how to peruse and how to compose. Rhyming is entertaining especially, when youngsters get the chance to toss in some of their own chatter words. This feeling of delight indicates posterity the information can be charming and rousing. Rhymes are over and again squat and have an endless replication in it. Duplication propose your creating kid the opportunity to song into contentions a moment and third time and aids him recall what he has quite recently seen. A rhyme's repeat can likewise profit understudy come to know about the segments of sound, known as phonemes, which make verses [11].

Speaking skills of the learners is enhanced through asynchronous multimedia mode of instruction, which can be blend with variety of instructional methods in order to promote fluency and accuracy of linguistics [12]. While on the other hand, synchronous blended learning environment provides to learners in the form of flexible and clear communication with the help of audios and videos [13]. Elucidation of rhyming verse out loud makes it less difficult for prior youngsters to learn new dialect verses. This is met all requirements to the musical development of the verses that help us to make a perceived structure to new and unidentified words. They are likewise introduced to verses that sound same however with different undertones and significations [14].

The dialect learning gadget that esteems about the world have industrialized to contribute this arithmetical intelligence of dialect by youngsters is “nursery rhymes” that for all intents and purposes all standards and tongues have ballads that are communicated to kids. Condition, finish our grown-up reflects neuron association, has conveyed a natural gadget to profit our newborn children number out the syllable get together and phonological (sound blend) directions of their first dialect so that all through the following year of life expectancy a child would dominant be able to 900 new words in their first dialect. We know it that nursery rhymes are truthfully similar to "music" to the child's ears the beat and tune helps the youngster examine how contribute of decisions takes feeling dialect and the sound similarity [15].

The utilization of tunes has hugeness from a constructivist strategy as they were utilized to help understudies assemble meaning and signification; from a socio-social perspective as far as understudy arrangement; and from a scholarly point of view in that in these cases they encouraged understudies make colleagues in learning. Of interest is the distinction in how educators and understudies saw the conclusions for learning in science, in light of how tunes were utilized for instructing and learning science in this schoolwork. The consequences of this examination have charges for science educators and the science training metropolitan in developing new instructional methodologies for the center school science classroom [16]. Similarly, using of rhyming, phonemic-consciousness, vocabulary mindfulness, word acknowledgment, and additionally general motivation are effective [17].

Analysts have prescribed a connecting amongst music and dialect improvement wherein absorbing music and proficiency exercises can upgrade understudy information. In exact, encounters that enhance vocabulary through understudies' commitment in singing stories that are rich in phonemic plans, for example, rhyme and similar sounding word usage, are much praised. Combining books with music-coordinated proficiency inclusions can moreover create youthful kids' involvement to dialect. This training-based research was coordinated in an early juvenile instruction setting with four classrooms of kindergarten understudies, containing understudies with uncommon necessities and English dialect students, in a vocabulary accomplishment explore [11].

Phonological responsiveness is a vital component of early proficiency and numerous youngsters’ battle to take in its essentials, for example, the ability of hearing syllables and rhymes inside the correspondence. The propose found inside this work is that as music and dialect have equal sound-related seeing procedure at that point planning cadenced activities, for example, music, could prompt expanded keen of the musical nature important to decipher early dialect and education aptitudes [18].

The outcomes of English rhymes on disparate record level of fundamental first grade in time of learning motivation and understanding start and ice care of communicated in English. Fifty-one members were from Wan Tan primary school in Ping Tung County. Direction of Ten-week English nursery rhyme and two thirty moment's session for each week were led. The greater part of the members was tried when the instruction. Through quantitative system

the information was gather including Alphabetic Recognition Assessment, English Learning Motivation Scale. Primary discoveries of this work are that English rhymes have critical impact on enhancing and stimulating of review first understudies [19].

Singing, rhyming, and narrating are a piece of each culture. By singing and rhyming to kids, guardians and parental figures are not just keeping conventions alive, they are encouraging kids to explain words, rehearse the pitch, volume and beat of their local dialect, and build up the tuning in and focus abilities basic for mental health and memory. Music, notwithstanding supporting all territories of youngster advancement and brain to cooperate to take in the sounds and implications of words in a fun and intelligent way. The reiteration of words encourages youngsters to envision the rhyming word and this, thus, sets them up to influence expectations when they to peruse [20].

RESEARCH METHODOLOGY

RESEARCH DESIGN

A research design was an arrangement of propel choices; determining the techniques and systems for gathering and breaking down the required data for an examination or research. It was likewise used to frame an efficient structure of research strategy and explains the greater part of the real parts in an exploration venture. It considered the investigation tests or gatherings, estimations, medicines or projects, and techniques for task, assessment and testing which should cooperate to endeavor to address the focal research addresses thus achieving the speculation in assertion or invalidation. The research conducted was an 'Experimental Study'. Experimental study is a study in which the analyst effectively controls the variables of the study.

DURATION OF THE EXPERIMENT

The researcher took fifteen poems from the Kindergarten book grade V. The experiment was carried out for eight continuous working days at Fazaia Inter School and College Chakala P.A.F Base, Nur Khan. Rawalpindi Pakistan.

PRE-TEST

Pre-test was an initial test figured out to define a learner's beginning stage understanding or the preparation for an educational contribution or way of study. In the Pre-Test 14 respondents were taken for research purpose. Respondents were asked to fill the questionnaire on the basis of the knowledge the already had. The focus of pre-test ingredients were the grammar, memorization, vocabulary, meaning and spellings of the students to check their learning level.

POST-TEST

Post-Test was administered to the children after eight days of experiment (blend of music) and consistently utilized as a part of blend with a pre-test to gauge their fulfillment and the productivity of the program. The researcher focused on the same ingredients of pre-test (grammar, memorization, vocabulary, meaning and spellings).

POPULATION

To proceed with the research about impact of rhyme and rhythm on children's learning at primary level of Fazaia Schools and Colleges of Rawalpindi Cantonment, the target population of study comprised of the 100 children at primary level of Fazaia Schools and Colleges Rawalpindi Cantt (Administration office Fazaia Schools, 2017).

SAMPLE AND SAMPLING TECHNIQUE

The sample of the study was comprised of 14 Kindergarten children of grade V by using purposive sampling technique.

INSTRUMENTATION

A questionnaire was developed for pre-test and post-test, comprised of two sections. One section was consisted of Multiple Choice Questions MCQs, while 5 short questions were included in the second section. Fifteen poems from the kindergarten book grade V were selected for the research purpose. The focus of the research instrument was to cover the grammar vocabulary, spellings meaning and memorization with the help of poems with the blend of audios and videos.

VALIDITY & RELIABILITY

To ensure the validity and reliability of the research, the researcher had included all the items in the pre-test and post-test based on the questionnaire, founded on the literature review of the study. Research tool was validated by

taking the help of experts in field of education. As a piece of their opinion, lacking in the tool were removed before carrying on with the further research. In order to check the validity of the research, education experts were concerned. SPSS version 21 was used to check the reliability of the research instrument.

DATA COLLECTION

The basic goal of this study was to explain the affairs which go under the impact of rhyme and rhythm with blend of audios and videos (synchronous mode) on the learning of the children at primary level. The basic reason for this explicit study was to not only highlight the importance of the rhyme and rhythm but also to improve the learning of the primary level students. Nevertheless, inducement in the performance and the assessment may have shown great impacts on the mind of the learners and giving the learners the sound environment as far as to help the learners to improve their learning. For the attainment of this goal numerical and factual researches and computations were likewise exploited as a part of a request to have unmistakable knowledge and thought about rhyme & rhythm and their subsequent impacts on the learning of the primary level children through blend of audios and videos. Another goal behind the conduction of this specific study was that the students at primary level are somehow lacking to produce good results in their educational career which itself is a big hurdle in the progress of any country because the primary level children are the future makers of any country. The children at this stage must be intelligent and sharp enough to produce results. And not only the result of the students was important, but the learning of the students was also important for their betterment. Children in general had seen fail to produce results because of the monotone in their learning and speech patterns. The students who were forced to learn without their interest fail to produce result at the end and hence their learning ceases and stops. So, the students and the teachers both needed to put lots of effort in this regard. Whereas rhyme and rhythm help the children and teachers to improve the learning of the students. An idea behind this research was that students tend to learn more with the help of rhyme and rhythm through blended learning. Students could easily express themselves with the help of the rhymes and rhythms used as a learning technique. Data were collected after treatment period.

RESULTS AND DISCUSSION

The ultimate goal of this research study is to clarify the concerns which go under the circumstance recognized with the impact of the rhyme and rhythm on the learning of the children at the primary level. For the accomplishment of this objective data has taken from the records of their scholastics practices and after that has been showed up in quantifiable structure.

Table 1: Pre-test Results

Sr. No.	Respondents	Grammar	Meaning	Memorization	Spellings	Vocabulary	Marks Obtained / Total Marks
1	Hina	0	1	1	1	8	11/15
2	Jawaria	0	1	1	1	9	12/15
3	Mohsana	0	0	0	1	6	7/15
4	Zuraiz	1	0	0	1	2	4/15
5	Ali	0	1	0	1	5	7/15
6	Namra	0	1	1	2	7	11/15
7	Muteeh	0	1	1	2	6	10/15
8	Asim	1	0	1	1	7	10/15
9	Sehrish	1	1	1	1	8	12/15
10	Ereeza	1	1	1	2	7	12/15
11	Moiz	0	0	1	1	7	9/15
12	Rashid	0	0	0	1	7	8/15
13	Minahil	0	1	1	2	7	11/15
14	Laraib	0	0	1	2	5	8/15

The table 1 mentioned the result of the Pre-test of the students, which reflects that the students were really weak in grammar. The sentence structure of the students was very weak. The researcher has noted that teachers in general used to follow the concept of Rote Memorization without focusing on the concepts of the students. This is why the students were weak in grammar but better in memorization. Although their learning was still not up to the mark.

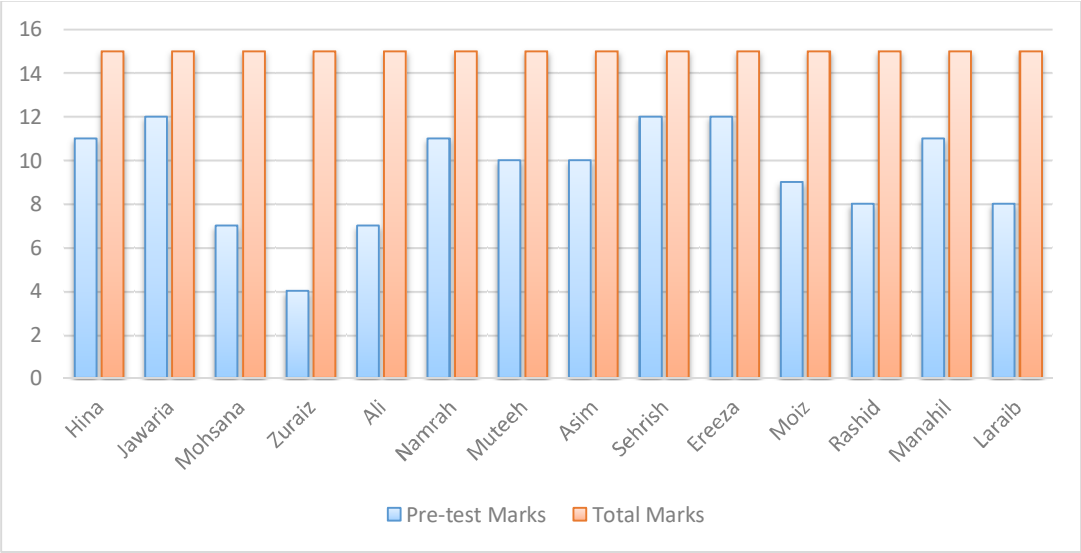

Figure 1: BAR CHART FOR PRE-TEST RESULT

The pre-test was based on Multiple Choice Questions MCQs and three long questions. Most of the students scored very few marks in structural question. One mark is declared for the grammar statement. Two marks are for the meanings that cover synonyms and antonyms. Nine marks for the vocabulary. The marking of the long questions was done according to criteria of 35% for memorization and 70% for the correct spellings. Out of fourteen learners only four learners secured maximum marks. And no student was able to get more than 12 marks in pre-test.

Table 2: Post-test Results

Sr. No.	Respondents	Grammar	Meaning	Memorization	Spellings	Vocabulary	Marks Obtained / Total Marks
1	Hina	0	0	1	2	9	12/15
2	Jawaria	0	2	1	2	9	14/15
3	Mohsana	1	1	1	2	8	13/15
4	Zuraiz	1	1	1	2	7	12/15
5	Ali	1	2	1	1	7	12/15
6	Namrah	1	1	1	1	9	13/15
7	Muteeh	1	1	1	1	8	12/15
8	Asim	1	0	1	1	9	12/15
9	Sehrish	1	1	1	2	8	13/15
10	Ereeza	1	2	1	2	9	15/15
11	Moiz	1	1	1	2	8	13/15
12	Rashid	0	0	1	0	7	8/15
13	Minahil	1	2	1	2	9	15/15
14	Laraib	0	1	1	2	9	13/15

Table 2 indicated the results of post-test, which shows improvement of the students in their learning after treatment period. Students showed interest in learning with rhyme and rhythm with blend of audios and videos. The researcher has noted that instead of rote memorization it is better to focus on the learning and concepts of the students.

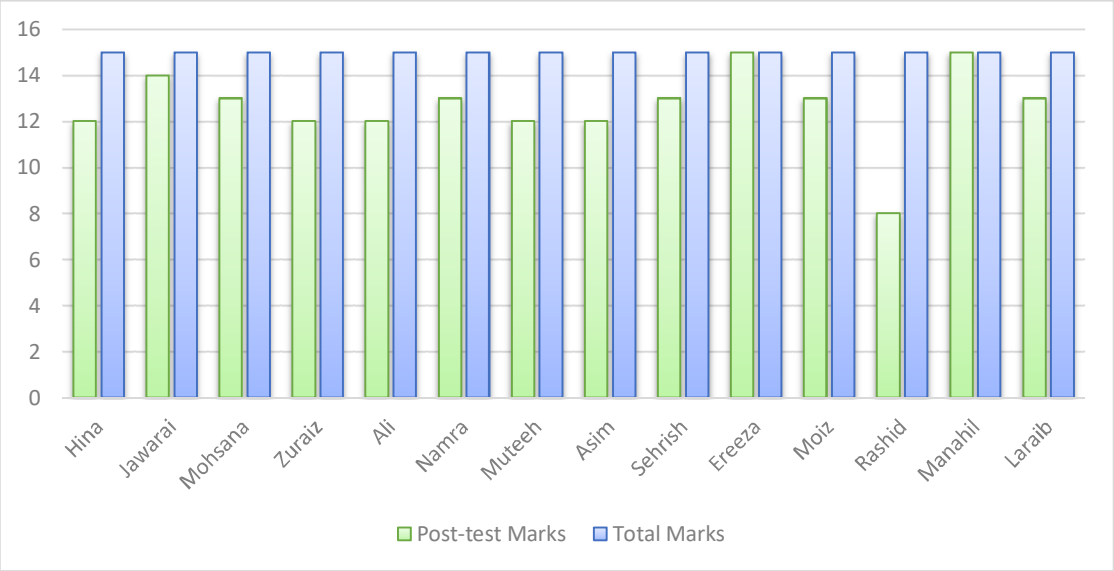

Figure 2: Bar Chart of Post-Test Result

Most of the learners showed improvement in the post-test conducted after teaching them for eight days. The post-test result is additionally categorized into three peer groups. Those learners who improved in the MCQ's section, those learners who improved in the long question answers and those learners who remained the same without improvement. Most of the learners showed improvement in MCQ portion and one of the students got the highest 100% in this section. This shows the student's ignorance or very little practice of the meanings and vocabulary. The second student's group showed upgrading in both MCQ and long questions. This section also includes 100% of the learners because every student improved in this particular section. The third group is of those students who did not show any improvement in the long questions portion. There may be two probable interpretations for this; one they might not attend the class on daily basis, or they did not find the lectures interesting. Anyhow, there is only one learner who failed to show any improvement in writing.

Table 3: Comparison between Pre-test and Post-test

Sr. No.	Name of Students	Pre-Test Result	Post-Test Result	Improvement Percentage
1	Hina	11	12	6.66%
2	Jawaria	12	14	13.33%
3	Mohsana	7	13	40%
4	Zuraiz	4	12	53.33%
5	Ali	7	12	33.33%
6	Namrah	11	13	13.33%
7	Muteeh	10	12	13.33%
8	Asim	10	12	13.33%
9	Sehrish	12	13	6.66%
10	Ereeza	12	15	20%
11	Moiz	9	13	26.66%
12	Rashid	8	8	0%
13	Minahil	11	15	26.66%
14	Laraib	8	13	33.33%

These improvement results show that maximum students improved their learning in following sections i-e spellings, grammar, vocabulary, meanings and memorization very quickly. Maximum improvement was shown by a learner with 53.3%. It means that if students are taught with rhymes, rhythms through blended synchronous mode and activities they can learn and improve the writing and speaking skills very efficiently. There is also a student who failed to show improvement in post-test result. This means that the student did not attend the classes with full attentiveness or the student might not like the way of teaching or either have no interest in activities.

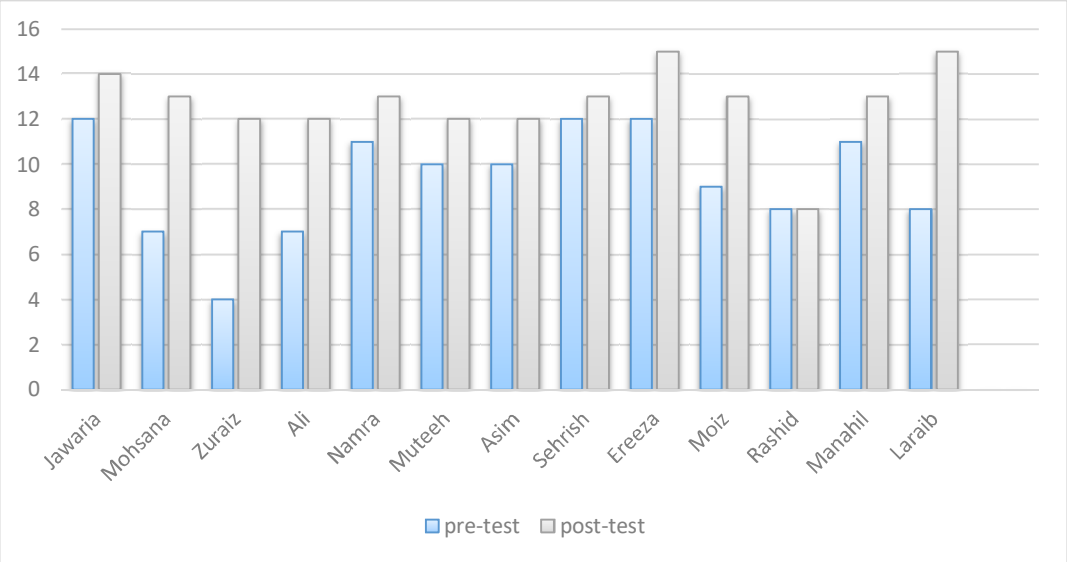

Figure 3: Comparison between Pre-test and Post-test

Figure 3 shows that the comparison between pre-test and posttest, which is indicated improvement of post-test scores of students as compared to pre-test.

FINDINGS

Based on the analysis of rhyme and rhythm in the learning of the primary level school children of Fazaia Inter School & College P.A.F Base NurKhan, following were the main findings of this study:

- **i.** After conducting and analyzing pre-test and post-test, the graph was plotted of the comparison of the pre-test and post-test. According to the graphs 13 out of 14 students showed improvement in their learning (Table 3; Fig 3)
- **ii.** According to the same tables and graphs, 57% had shown above 20% of the improvement in their post-test (Table 3).

CONCLUSION

To conclude the findings, it can be said that in Fazaia Inter School & College P.A.F Base NurKhan, learners at primary level find the learning easy with the help of rhyme and rhythm through synchronous blended learning. Those students who were least interested in studies starts showing results. The learning of the students was improved at every level i-e grammar, memorization, vocabulary, meanings (synonyms and antonyms), and spellings. Students in the pre-test lack in the above-mentioned aspects of learning may be lack of interest in the studies, lack of exposure to the studies, low ambitions. But the students after being taught with the proper rhyme and rhythm in the class by the researcher have shown improvement not only in their learning but they also seemed confident enough in the class. Their aspect towards learning had also been changed. Rhyme and rhythm improves the learning of the students. Moreover, it can also be concluded that the teachers who had problems in producing the results of the students have also find out the gateway towards the improvement of the student's results.

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Analysis of Thermal Conditions in the Wamanggu Market

Muchlis Alahudin

Architecture Department of Universitas Musamus, Merauke, Indonesia

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ABSTRACT

The purpose of this study was to determine the thermal conditions inside and outside of buildings in the Wamanggu market. In this study using descriptive methods, the data analyzed include; building area, ventilation size, area of stall/booth inside the heat, and thermal measurements (temperature, humidity and wind speed in the market. Thermal measurements are carried out in 2 places; 1). Outside the building (taken about 5 m from the building), 2). Inside the building (measured by 2 heights, on the floor surface, height 70 cm and 160 cm). measurements were taken on the 2nd floor of the Wamanggu market. Thermals measured include; 1). Temperature, 2). Humidity and 3). Wind velocity. Currently, the temperature conditions in the Wamanggu market are included in the Warm Comfortable category with an average temperature of 28.7ºC, outside the market building, an average temperature of 29.4ºC. The humidity in the space in the market is in the Optimal Comfortable category, the average humidity in the building is 66.8% - 83.3% with an average of 74.6%, outside the building 64.8% - 77.9% with an average humidity of 71.9%, measuring height 70 cm. Wind speed in buildings between 0.1 m/s - 0.8 m/s with an average of 0.4 m/s, outside the building ranges from 1.3 m/s - 3.1 m/s an average of 2.1 m/s. The temperature in the Wamanggu market is quite high because the air circulation is not going well, due to the placement of merchandise sellers who occupy the aisles/roads between the kiosks.
KEYWORDS: Thermal Comfort, Wamanggu market, Merauke

1. INTRODUCTION

Papua is one of the regions in Indonesia that has great potential in developing trade businesses. One of the regencies located in Papua province, Merauke, is the regency with the greatest potential in food development, which previously during the Dutch colonial administration was once developed into a granary for the South Pacific region through the Kumbe Rice in 1939-1958. Besides being well-known as a rice-producing district in Papua, Merauke Regency is also famous as a producer of bananas because of the large number of bananas produced. In 2010, banana production reached 10,901.30 tons from a harvest area of 771 ha.

In the field of horticulture, Merauke Regency also has great potential. In 2010, the harvested area for vegetables in Merauke Regency was 434.35 ha. Horticultural commodities that have potential in Merauke Regency are; shallots, chillies, cabbage, cabbage, tomatoes, eggplant, water spinach, long beans, spinach and cucumbers. From the harvested area, long bean harvested area is the largest, reaching 83.50 ha (19.23 percent), so long beans are the most vegetable production which reaches 813.88 tons. Of the many agricultural production in Merauke, the most products are marketed in two places, namely the temporary market Jl. Merauke Youth and big market / parent Wamanggu Jalan Paulus Nafi Merauke.[8]

Wamanggu Market is a market that opened in the city of Merauke on April 25, 2013. This market has a semi-mall market concept that combines the concepts of traditional markets and modern markets. This market is on a land with a total area of 21,167 m2 and a building area of 15,030 m^2, this building consists of 3 floors with 4 blocks intended for various types of merchandise. The total number of kiosks / stalls is 1,140 units, 714 units on the 1st floor, 410 units on the 2nd floor and 16 units on the 3rd floor.[8]

2. LITERATURE REVIEW

A. Market definition

The market has a very close relationship with the economic activities of society, both production, distribution and consumption. In this case the market can be interpreted as an arena of distribution or exchange of goods, where the interests of producers and consumers meet and in turn determine the continuity of economic activity of the people. Ginanjar (1980) argues that the market is a place to sell and market goods or as a form of collecting trading activities. In the beginning the market was a turnaround and a meeting between inventory and supply of goods and services. The market can be defined as an institution or mechanism where buyers (who need it) and sellers (who produce) meet and jointly exchange goods and services [5]. The market is as people who have needs to be satisfied, have money to spend and a willingness to spend money. The market is where the

Corresponding Author: Muchlis Alahudin, Architecture Department of Universitas Musamus, Merauke, Indonesia.
Email: muchli@unmus.ac.id

buyer meets the seller, the goods or services offered for sale and then the transfer of ownership occurs. Look at the meaning of the market in several ways, including:

1. In its original sense, the market is a physical place where buyers and sellers gather to exchange goods and services.
2. For an economist, the market implies all buyers and sellers who sell and conduct transactions on certain goods / services. In this case economists are indeed more interested in the structure, behavior and performance of each of these markets.
3. For a market marketer is a set of all real buyers and potential buyers of a product.

Based on the management patterns used, the market can be divided into two major groups, namely:

a. Traditional Market, is a market that still uses a very simple management pattern with the characteristics that every trader has one type of business, there is interaction between sellers and buyers (bargaining prices), placement of goods is aligned less neatly arranged, comfort and safety are less heeded.
b. Modern Market, is a market that has adopted modern management patterns, with the characteristics of the type of merchandise carried out by one trader, fixed prices, layout of merchandise organized properly and neatly, comfort and safety have become the top priority.

In the Decree of the Minister of Industry and Trade No. 23 / MPP / Kep / 1/1998 concerning Trade Business Institutions, the market is defined as a place where the seller and buyer meet to carry out transactions where the buying and selling process is formed. Market according to the class of service can be classified into traditional markets and modern markets, while according to the nature of its distribution can be classified into retail markets and wholesale / wholesale markets. Traditional markets are defined as markets built by the government, private sector, cooperatives or non-governmental organizations with business premises in the form of shops, kiosks, booths and tents owned / managed by small and medium traders or cooperatives with small scale businesses and small capital through the buying and selling process through bargaining.

B. Protection of Traditional Markets

The protection referred to is based on the Regulation of the Minister of Trade of the Republic of Indonesia Number: 53 / MDAG / PER / 12/2008 Regarding Guidelines for Structuring and Guiding Traditional Markets of Modern Shopping Centers and Stores Article 1 paragraph 1-2, paragraph 3-5, Article 22 paragraph 8. Some The impact of market protection by the government on traders is as follows: 1) Economic impact a. The possibility of access to capital b. The possibility of an increase in income that encourages increased welfare of the community c. Possible opportunities for opening new businesses 2) Social impacts a. Possible emergence of more modern patterns of behavior of market traders b. The possibility of changes in the benchmark behavior of traditional market traders in the market c. Possibility of development of public facilities and facilities.

C. The Concept of Thermal Comfort

Architectural conditioning in the building can be done architecturally by considering the placement of buildings (the orientation of buildings to the sun and wind), the use of architectural and landscape elements and the use of materials / building materials that are in accordance with the character of the humid tropical climate. Through the four things above, the temperature in the room can be reduced several degrees without assistance.[4], [6]

1. Building Orientation
   a. Orientation to the Sun.
      The greater the area that receives direct solar radiation, the more heat the building receives.
   b. Wind Orientation (Cross Ventilation)
      A pleasant wind speed in the room is 0.1 - 0.15 m/s. The amount of air flow rate depends on:
      - free wind speed
      - Wind direction towards ventilation holes
      - Area of ventilation holes
      - The distance between the air inlet and outlet
      - Barriers in the room that block the air.
2. Architectural Elements
   - Sun visor
   The position of buildings in the East and West directions cannot be avoided, so a free view through the window on this side must be avoided because heat radiation directly entering the building (through openings / glass) will heat up the room and raise the temperature / air temperature in the room
3. Landscape Elements
   - Vegetation
   Landscape elements such as trees and vegetation can also be used as protection against solar radiation. The presence of trees directly / indirectly will reduce the temperature of the surrounding air, because solar radiation will be absorbed by the leaves for photosynthesis and evaporation.

However, if the laying of vegetation is not well ordered, it can hold the wind speed. Trees as 'windbreak' can reduce wind speed by more than 35% if the distance from the building is 5 x the height of the tree.

- Water element

The presence of water will reduce the temperature of the surrounding air due to the absorption of heat in the process of evaporation of water. In addition to lowering air temperature, the evaporation process will increase humidity.

4. Building Materials / Materials

The amount of solar radiation transmitted through the building envelope is affected by the building facade, which is the ratio of the area of the glass and the area of the wall of the whole building (wall to wall ratio). On the west side the temperature tends to be lower because during the day the west side is still exposed to shadows from the building itself, after the sun shifts from approximately 02.00 to 16.00 wita, the west wall is exposed to direct sunlight, solar heat radiation received by the east wall is bigger than the west wall [11].

The Standard of Procedures for Technical Planning for Energy Conservation in Buildings published by the LPMB-PU Foundation divides the comfortable temperature for Indonesians into three parts as follows:

Table 1. Comfortable Standards of Temperature and Humidity

Condition	Effective temperature	Humidity
Cool Comfortable **Upper threshold**	20°C – 22,8°C 24°C	90 % 80%
Optimal comfort **Upper threshold**	22,8°C – 25,8°C 28°C	70%
Warm Comfortable **Upper threshold**	25,8°C – 27,1°C 31°C	60%

Source: [3], [12]

5. Merauke Wamanggu Market

a. Wamanggu market capacity:

Table 2. The capacity of the Wamanggu market

Floor	Kiosk	Los
1	71	207
2	410	410
3	16	
Total	497	617
Total Kiosk dan Los		1,114

Source: [8]

b. Wamanggu market actual / real capacity:

As of October 2016, there are 783 units actively selling in the Wamanggu market, consisting of booths and kiosks.

Table 3. Survey results of the number of market traders in Wamanggu Merauke

No	Group name	Tracers location
		Wamanggu market
1	Clothes and shoes	131 units
2	Electronic, broken, mixed	48 units
3	Spices, Vegetables, Fish, Meat, Fish, Groceries	604 units
Amount		**783 units**

Source: [8]

3. METHODS

In this study using the method of observation, the data analyzed include; building area, ventilation size, stall / booth area in the heat, and thermal measurements (temperature, humidity and wind speed in the market. Thermal measurements are carried out in 2 places; 1). outside the building (taken approximately 5m from the building), 2). Inside the building (measured by 2 heights, on the surface of the floor, height 70cm and 160cm). measurements were taken on the 2nd floor of the Wamanggu market. Thermals measured include; 1). Temperature, 2). Humidity and 3). Wind velocity. Useful method was provided in [9].

4. RESULTS AND DISCUSSION

Wamanggu Market is a market that opened in the city of Merauke on April 25, 2013. This market has a semi-mall market concept that combines the concepts of traditional markets and modern markets. This market is located on the street Paulus Nafi Merauke District, on land with a total area of 21,167 m^2 and building area of 15,030 m^2, this building consists of 3 floors with 4 blocks intended for various types of merchandise. The total number of kiosks / booths is 1.1140 units, 714 units on the 1st floor, 410 units on the 2nd floor and 16 units on the 3rd floor. On the 2nd floor of the Wamanggu market there are 410 kiosk / booths with a corridor width of 2m. Stalls / booths on the 2nd floor are intended for sales: 1). Shoes and sandals, 2). Clothing and fabric, 3). Furniture, 4). Jewelry, 5). Cosmetics and 6). Electronics

From the results of thermal measurements carried out to find out; 1). Temperature, 2. Humidity and speed of the air, measured both inside and outside the building. For measurement buildings, there are 8 measuring points, placing the measuring points in the selling and lobby areas. While outside the building there are 2 measuring points namely beside the left and right buildings taken 5 m from the edge of the building. Height measurement of 70 cm (according to the height of the table where it sells) and height measurement of 160 cm (height of the average human standing).

A. Effect of air temperature

The results of measurements at a height of 70 cm obtained a temperature in the building between the hours of 08:00 to 17:00 CET temperatures between 27.4ºC - 30.1ºC with an average temperature of 28.7ºC enter in comfortable warm conditions. While outside temperatures between 27.9ºC - 31.9ºC with an average temperature of 29.4ºC for temperature conditions, both inside and outside enter the warm comfortable category. Measurement data at a height of 70 cm can be seen in table 4.

Table 4. Indoor and outdoor temperature measuring height 70 cm

No	Time	Temperature (ºC)	
		Indoor	Outdoor
1	8:00	28.3	28.77
2	9:00	28.3	28.97
3	10:00	28.4	29.07
4	11:00	29.1	30.17
5	12:00	29.4	30.57
6	13:00	30.1	31.87
7	14:00	29.1	29.57
8	15:00	29.1	29.27
9	16:00	27.8	27.87
10	17:00	27.4	28.07

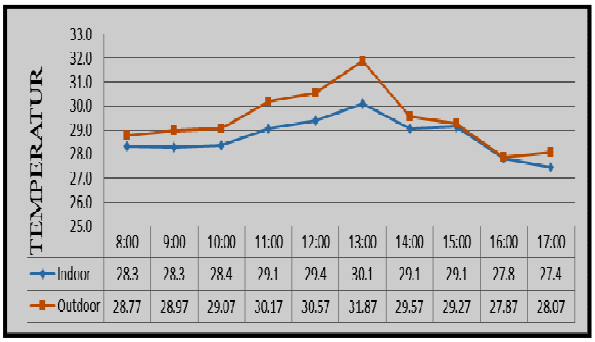

Figure 1. Temperature at a height of 70 cm

Whereas for measurements inside buildings with a height of 160 cm the temperature is between 27ºC - 30.8ºC with an average of 28.7ºC, for outside the building the temperature is between 28.3ºC - 31ºC with an average of 29.4ºC, temperature information can be seen in table 5. The highest temperature is good inside or outside the building occurs at 12.00 - 13.00 WIT

Table 5. Indoor and outdoor temperature measurements of 160 cm height

No.	Jam	Temperature (ºC)	
		Indoor	Outdoor
1	8:00	28.4	28.30
2	9:00	28.3	28.40
3	10:00	28.2	28.60
4	11:00	29.0	30.40
5	12:00	29.4	30.20
6	13:00	30.0	31.00
7	14:00	29.3	29.30
8	15:00	29.1	29.40
9	16:00	27.8	28.50
10	17:00	28.2	29.40

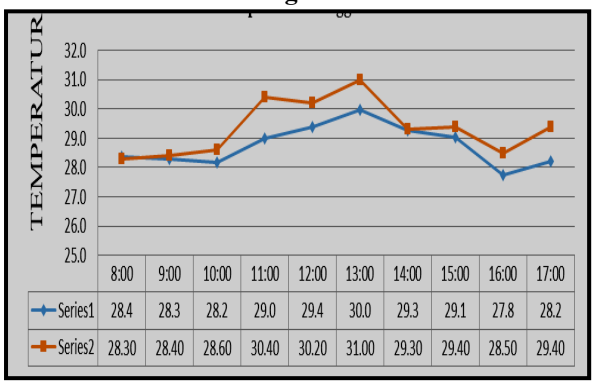

Figure 2. Temperature at a height of 160 cm

B. Effects of Air Humidity

Humidity measurement with a measurement height of 70 cm from the floor humidity between 66.8% - 83.3% with an average of 74.6%, with the humidity for space in the Wamanggu market or at the position of the seller's table in the Optimal Comfortable humidity category. For outside buildings with the same height humidity ranges between 64.8% - 77.9% with an average humidity of 71.9%. Moisture data on measurements of 70 cm can be seen in table 6.

Table 6. Indoor and outdoor humidity measurement height of 70 cm

No	Time	Humidity (%)	
		Indoor	Outdoor
1	8:00	28.4	76.7
2	9:00	28.3	76.4
3	10:00	28.2	74.7
4	11:00	29.0	72.2
5	12:00	29.4	67.5
6	13:00	30.0	64.8
7	14:00	29.3	65.1
8	15:00	29.1	67.8
9	16:00	27.8	75.8
10	17:00	28.2	77.9

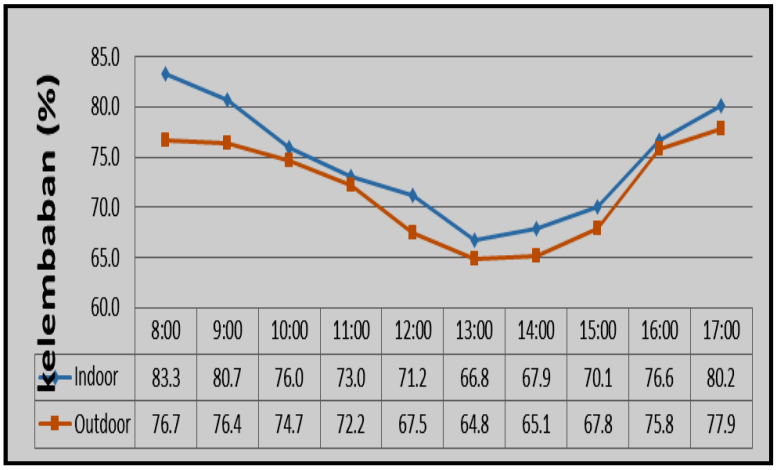

Figure 3. Humidity at a height of 70 cm

With a height measurement of 160 cm, inside the building the humidity is between 67.8% - 83.3% with an average of 74.7, for outside the building ranges from 64.8% - 76.7% with an average of 71.5%. The measurement results both inside and outside the building enter the Optimal Comfortable category. Data from the measurement of humidity at a height of 160 cm inside and outside the building can be seen in table 7.

Table 7. Indoor and outdoor humidity measurement heights of 160 cm

No	Time	Humidity (%)	
		Indoor	Outdoor
1	8:00	28.4	76.7
2	9:00	28.3	76.4
3	10:00	28.2	74.7
4	11:00	29.0	72.2
5	12:00	29.4	67.5
6	13:00	30.0	64.8
7	14:00	29.3	65.1
8	15:00	29.1	67.8
9	16:00	27.8	75.8
10	17:00	28.2	77.9

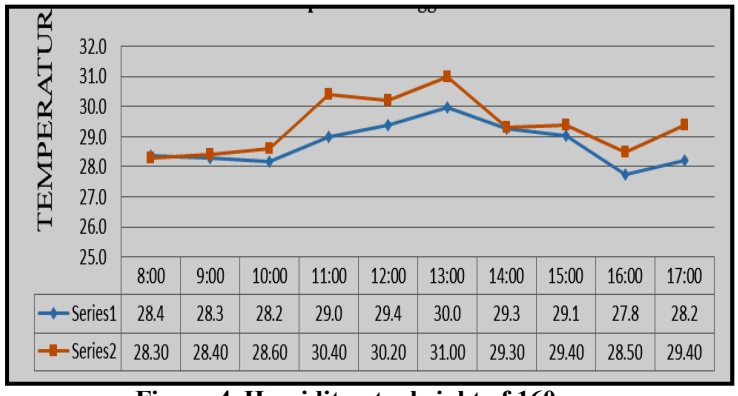

Figure 4. Humidity at a height of 160 cm

C. Effect of Wind Velocity

Measurement of wind speed is measured both inside the building and outside the building with a height of 100 cm from the surface of the floor, for inside the building the wind speed ranges from 0.1 m/s - 0.8 m/s with an average of 0.4 m/s, while for outside the building ranges between 1.3 m/s - 3.1 m/s average of 2.1 m/s measurements outside the category of weak wind but the movement of the wind can be felt by the body. The speed of wind outside is not comparable to inside because the openings in the Wamanggu market are not many, and the facilities provided as cross ventilation are mostly covered by merchandise at market sellers.

Table 8. Indoor and outdoor wind velocity height of 100 cm

No	Time	Wind velocity	
		Indoor	Outdoor
1	8:00	0.5	2.8
2	9:00	0.6	1.4
3	10:00	0.4	1.3
4	11:00	0.4	1.7
5	12:00	0.8	3.0
6	13:00	0.5	3.1
7	14:00	0.6	2.7
8	15:00	0.3	1.8
9	16:00	0.2	1.7
10	17:00	0.1	1.4

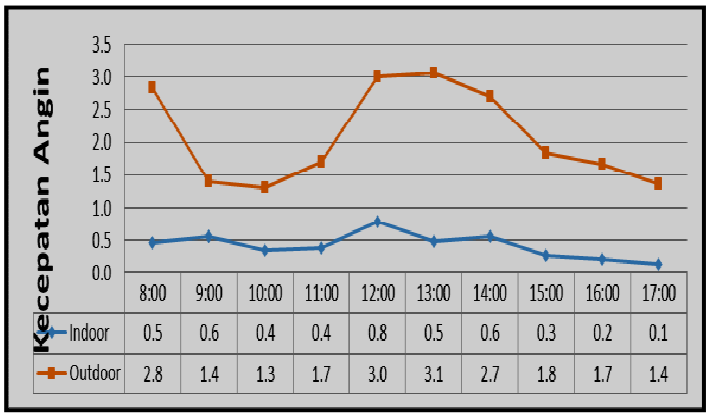

Figure 5. Wind velocity

5. CONCLUSION

Currently, the temperature conditions in the Wamanggu market are included in the Warm Comfortable category with an average temperature of 28.7ºC, outside the market building, an average temperature of 29.4ºC. does not rule out the fore future conditions in the building of Warm Comfort can increase in the Heat category because the number of sellers and buyers will increase. The humidity in the space in the market is in the Optimal Comfortable category, the average humidity in the building is 66.8% - 83.3% with an average of 74.6%, outside the building 64.8% - 77.9% with an average humidity of 71.9%, measurement height of 70 cm. Wind speed in buildings between 0.1 m/s - 0.8 m/s with an average of 0.4 m/s, outside the building ranges from 1.3 m/s - 3.1 m/s an average of 2.1 m/s.

The temperature in the Wamanggu market is quite high because the air circulation is not going well, due to the placement of merchandise sellers who occupy the aisles/roads between the kiosks. Besides that the condition of building openings is indeed not good (seen from the percentage of building openings with market floor area).

With high temperatures in the market and low humidity and low air circulation inside the building, these conditions make the conditions in the market building uncomfortable.

As suggestions: market manager need awareness of the seller so as not to place merchandise in the hallway / road between the kiosks. Structuring the space pattern in the market building needs to be done, to make the most of the space in the building column it would be better not to be in the middle of a kiosk (selling place). Market manager also need to install exhaust fans in several parts of the market, especially in the sale of fish and meat.

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The Challenges of Implementing Phytodrainage for Urban Areas

Abdul Hamid

Head of East Java Province Library and Archives Service, Jalan Menur Pumpungan 32, Surabaya, Indonesia

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ABSTRACT

Drainage is the drying of rainwater precipitation on the surface of the earth. Natural drainage technology infects rainwater into the ground and drains rainwater on surface water bodies. The physical form of natural drainage technology by infiltration is permeable soil cover, which is in the form of green open spaces of plants the so called phytodrainage. The physical means of natural drainage technology in the drainage of the land surface are rivers, lakes and the like. Drainage technology based on practical methods of changing quality loads proves that reducing green space for the expansion of living infrastructure (including settlements) results in an excess of quality burden for water bodies. Attenuation of the impact of drainage channels on water bodies requires a study of the placement of ponds or the like to reduce fluctuations in the quality of the water body.
KEYWORDS: rainwater, infiltration, permeable soil cover, phytodrainage

1. INTRODUCTION

Changes in land cover due to various activities of human life (construction of buildings, roads and other infrastructure) result in changes in the hydrological response [1]. Quantitatively, the hydrological response in question is, among others, a decrease in the infiltration of rainwater into the soil and an increase in runoff of rainwater at the ground surface. Qualitatively, an increase in runoff causes increased soil erosion, and with the addition of human life activities, it continues with an increase in contaminants in runoff to the level of rainwater pollution. Coverage of various pollutant sources on a regional scale characterizes polluted rainwater as a carrier medium for non-point pollution, which ends up leading to a centralized disposal point in a body of water (rivers, lakes, estuaries).

Potential rainwater runoff pollution is expressed as an area load, which is formulated as follows: *Load area (Ba) = Qr * A * C*. Qr is rainwater runoff discharge, obtained from the hydrograph unit (mm $year^{-1}$), C is the quality of contaminants (mg L^{-1}) and A is the area of rainwater runoff (km^2).

The area load changes to a water quality load in the drainage channel: *Load (B) = Qd * Cd*. Qd is the rainwater discharge in the drainage channel (m^3 sec^{-1}) which drains the rainwater Qr for area A, and Cd is the quality of rainwater in the drainage channel (mg L^{-1}) whose number and amount are the same as C.

Some of the challenges of applying phytodrainage are described below. This is intended to be the preparation of a rainwater drying program during the rainy season. Its application is mainly for the tropics.

2. Drainage channel

Drainage channel is made to drain rainwater runoff. Some of the contaminants that did not undergo gas transformation carried in the drainage channel with a load of Qd * Cd. The discharge of drainage runoff into water bodies adds to the quality burden of existing water bodies (Qb * Cb). Water bodies before getting input of drainage runoff (dry season) have a quality burden [2], which comes from deep ground water sources and surface water. During the rainy season and the water body gets input of drainage water, the quality of the water body becomes the following mixed quality load: *Qc*Cc = Qb*Cb + Qd*Cd.* Notation c is a body of water mixed with drainage water, d is drainage water, and b is a body of water without drainage water.

3. Drainage and material channels made permeables

Drainage problems in developed countries, especially the USA are solved by the choice of using permeable materials, namely paving stones. The development of drainage technology to reduce impacts on water bodies is known as low impact development (LID). Drains that drain rainwater runoff coupled with the construction of artificial permeable materials translate into an interrelation of environmental impacts. In the rainy season, rain water falls over the contaminants that are present in the soil surface and from the results of human activities. The process that occurs is that some of the contaminants in the runoff are transformed into carbon dioxide which is released into the air.

Some of the contaminants that did not undergo gas transformation carried in the drainage channel with a load of Qd * Cd. During rainwater runoff in contact with permeable artificial material, part of the load is released

Corresponding Author: Abdul Hamid, Head of East Java Province Library and Archives Service, Jalan Menur Pumpungan 32, Surabaya, Indonesia. Email: abdul.hamidkiram@gmail.com

into the soil infiltration (Qi * Ci). Drainage discharge into the water body adds to the quality burden [3] of the existing water body (Qb * Cb). Water bodies before getting input of drainage runoff (dry season) have a quality burden, which comes from deep ground water sources and surface water. During the rainy season and the water body receives input of drainage water that has been reduced by infiltration through permeable material, the water quality load becomes the following mixed quality load: $Qc*Cc = Qb*Cb + Qd*Cd – Qi*Ci$.

4. Phytodrainage concept

In the rainy season, rainwater drops over the contaminants that are on the surface of the soil and the result of human activities. The process that occurs is that some of the contaminants [4] in the runoff are transformed into carbon dioxide that is absorbed by plants.

Some contaminants that do not undergo gas transformation are carried away in phytodrainage with a Qd * Cd load. During rainwater runoff in contact with plants, part of the load is released into soil infiltration (Qi * Ci) and plant uptake (Qt * Ct). Disposal of phytodrainage runoff to water bodies reduces the quality burden of existing water bodies (Qb * Cb). The application of phytodrainage results in a mixed quality body water load, which is smaller than that of the drainage channel, due to the reduction in the quality burden by infiltration (Qi * Ci) and the following plant uptake (Qt * Ct) quality load: $Qc*Cc = Qb*Cb + Qd*Cd – Qi*Ci – Qt*Ct$.

Qualitatively demonstrated the superiority of phytodrainage over drainage channels in suppressing environmental impacts. But realistically, phytodrainage may not be able to replace the drainage channels because the capacity of plant processes is a certain natural nature which is not as flexible as developed drainage channels. Therefore it is necessary to study the optimization of the feasibility of phytodrainage in the urban drainage system as a whole. An example is the intensification of plant retention ponds (phytoretention ponds), which are placed in each building and certain road network segments; the remaining rainwater runoff is completed by the drainage channel.

5. Drying stagnant water

Application of plant retention ponds requires indicators of the ability of plants to drain water developed plant pump indexes in the field of evapotranspiration. Plant pump index is defined as the ability of plants to absorb water through the roots and release it through the surface of plants, which are driven by sunlight energy. Water flow through roots (transpiration flow) plus evaporation flow (E) is evapotranspiration flow (Et). The pumping rate of plants is measured as a transpiration factor and expressed as an Et / E ratio greater than 1. The pumping ability must be balanced with the continuity of plants to carry out the evapotranspiration process. Guaranteed continuity of plants is technically expressed as a relative growth rate (RGR). The Et and RGR parameters are obtained through laboratory or field experiments. Plants are declared capable of natural pumps if the plant pump index has a high Et / E ratio accompanied by a low RGR.

6. Atenuation of impact of drainage for water bodies

Drainage water disposal can be carried out into the environment:

1) Surface water bodies, which can be:

a) River, potential for high and low altitude areas.

b) Coastal lakes and wetlands (natural stagnant water bodies) and reservoirs / artificial stagnant water bodies, which are potential for lowland and coastal areas.

c) Sea, potential for coastal areas.

2) Injection into deep groundwater bodies, which are potential for drought prone areas and prone to sea water intrusion.

Of the various drainage impacts on water bodies, two types of impacts that require important attention are impacts on:

1) Water body assimilation capacity (KAb). KAb is the ability of a water body to accommodate quantity (Q) and process quality (C). Q is inert (the structure of the object does not change, for example H2O remains H2O even though it is cooled or heated); the effect of adding Q results in the accumulation of Q. While C is inert (= conservative, for example NaCl remains NaCl even though it is cooled or heated) and some is non-conservative (the structure of the body changes, eg BOD dissolves into CO2 gas); the effect of adding C can be synergistic, antagonistic, additive, accumulative, multiplicative. If the accumulation of Q can still process additional C (change the form of substances), then the body of water has an assimilation capacity (KAb) to its input. As per the water body's assimilation capacity definition, KA is a measure of the impact event. Drainage impacts occur if the quality load is mixed with water bodies (Qc * Cc)> KAb.

2) Fluctuations in water body loads. Both quantity (Q) and quality (C) occur naturally in each drainage channel and water body. Fluctuations in the maximum load need to be the focus of attention, because it is likely to exceed the assimilation capacity of water bodies. The maximum load fluctuation factor becomes a measure to determine the occurrence of the impact of drainage on a body of water, formulated as follows: Fbm = Q * C (max) / Q * C (average).

1) The determination of KAb and Fbm is by monitoring the Q and C of water bodies and drainage channels that exist in the rainy season. Table 6.4 presents the results of monitoring Q and C of a river and upstream city drainage channel accompanied by a calculation of the quality load for both the water body and the upstream city drainage channel. While Table 6.5 presents the results of monitoring Q and C of the city downstream drainage channel accompanied by a calculation of the quality load for both the same river and the downstream drainage channel of the city.
2) Based on this monitoring it was determined that KA was 2.5 kg sec^{-1}. River Fbm without downstream city drainage is 2,160 / 1,331 = 1,623, Fbm downstream city drainage is 0,612 / 0,143 = 4,279, and River Fbm is mixed with downstream city drainage is 2,412 / 1,475 = 1,635. In these conditions it is known that:
    a. No drainage effect on river KAb (mixed quality load = 2,412 kg det-1 <KA = 2.5 kg det-1).
    b. There was a time shift in the Fbm river occurrence from the 10th week (river without drainage downstream of the city) to 12th week (river with downstream drainage of the city).
    c. The impact of an increase in river Fbm from 1,623 (river without drainage downstream of the city) to 1,635 (river mixed with downstream drainage of the city).

7. Infrastructure of load fluctuation

The two examples above give a description of drainage that can give effect to KAb while not affecting the Fbm of the river. Likewise the impact occurs on river Fbm but does not affect KAb. Of course drainage water disposal is not expected to have an impact on both KAb and Fbm water bodies. For this reason, the impact attenuation method is needed to reduce the fluctuation of the maximum drainage load [5].

The technological approach adopted is the addition of new water bodies that can reduce load fluctuations. Practical experience is the addition of stagnant water bodies, for example ponds / reservoirs. The system faced is to reduce the fluctuating load (QC, or VC) to less volatile loads and set the pool volume (Vk). The problem faced is which drainage canals should enter the additional pool to produce fluctuations in the output load lower than fluctuation in drainage loads.

8. Applied phytodrainage

In a phytotechnology perspective, man-made drainage infrastructure is the last work or the rest of the work after nature completes it. Therefore, it is important to provide natural infrastructure as much as possible, so that man-made infrastructure becomes small, small and cheap and has little impact on the environment. The available natural infrastructure is the body of river water, lakes, wetlands, and land. The capacity of the soil to dry rainwater by infiltration can be increased by expanding the area of land permeability using plants (phytodrainage).

Phytodrainage (origin term: biodrainage) has been developed in developed countries since the 1970s, especially in the USA. Phytodrainage starts from the roof of the house (vegetated roof) and continues to drainage the road using a combination of paving and grass. The use of vegetated roofs in Indonesia has not yet been found, but in some places small and partial scales have used phytodrainage.

Plant pump index research in the field of evapotranspiration reveals the ability of plants to absorb water through roots and release it through the surface of plants, which are driven by solar energy. Water flow through roots (transpiration flow) plus evaporation flow (E) is evapotranspiration flow (Et). The quantitative plant pump index is expressed as a transpiration factor (Tr) and expressed as an Et / E ratio greater than 1. The meaning of Et / E> 1 in drainage is that phyodrainage dries rainwater more often than in the drainage channels without plants.

The research also states that the use of plants can improve water quality [6]. In this case phytodrainage can improve the quality of rainwater runoff, in addition to providing the availability of ground water and minimize standing water. Going forward, phytodrainage can be effective and efficient in the use of resources as well as minimizing the impact of rainwater runoff, by means of an integrated regional system approach. Namely, phytodrainage starts from housing and continues in residential areas and continues on the road network. Old residential areas and new development should start to rearrange road construction. At the same time improving the drainage system using paving, and in some asphalt intersections provided facilities parks.

CONCLUSION

Man-made drainage technology to increase infiltration is to increase the permeability of land cover by using paving stones or the like. Man-made drainage technology for flowing runoff is a drainage channel using various types of construction. Phytodrainage and / or paving stone placement in the drainage channel makes drainage technology effective both in solving quantity problems and improving runoff water quality.

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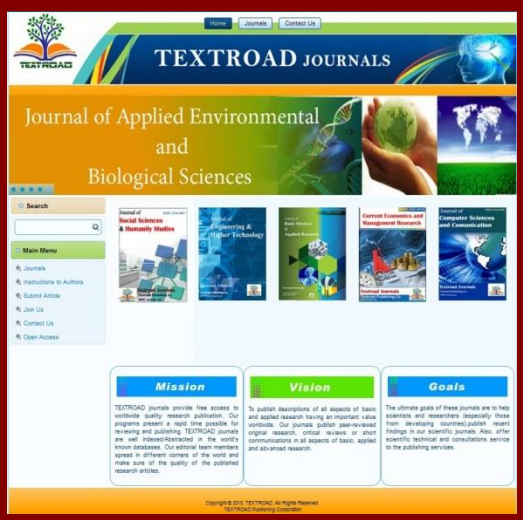

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