Effect of Time-of-Day on Learning of Mathematics: A Case of Secondary Schools in Karachi

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Abstract

This study aimed to determine the effect of time of day on learning Mathematics by examining the optimal time of day to teach mathematics in a high school setting. Using a quantitative study, the data was gathered from high school students in Karachi-based schools. Classroom polls were used to obtain data for this research study. The sample included high school students, currently enrolled in VII grade (sections E and F). The school was associated with the Aga Khan Board. The findings of the study revealed a statistically significant relationship between time-of-day and the learning achievements of students and students' performance in mathematics. As students learn more efficiently when they are taught and graded during their preferred time of day; therefore, it is recommended that parents and school management should pay attention on the students' preferred learning timing.

Keywords: Learning of Mathematics, Preferred learning timing, Secondary Schools, Time-of-Day

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INTRODUCTION

Students differ from one another in terms of their ability and promptness, just like everyone else. Mathematics is a subject that necessitates student engagement and active participation and a new mind-set to maximize problem-solving skills. After a restful night's sleep and nutritious breakfast, students' minds are at their sharpest in the morning. This is a perfect moment to pick up a textbook and learn something new or go over notes from the day before. Successful instructing depends on a few factors: encouraging feedback, advance coordinator, signs and input, higher request addressing, positive study hall climate, and cooperative learning[1]. To this end, numerous techniques and methodologies have been distinguished and polished that have delivered better and empowered outcomes. Practical learning is the most broadly utilized and favoured education technique[2]. Agreeable learning is an instructing strategy that assists understudies with learning together in gatherings to expand their learning with incredible interest and inspiration[3]. Instruction is fundamental to a feasible turn of events and cooperative learning guarantees a supportable future turn of events[4].

For pupils who have more energy in the morning, studying in the morning may be the ideal option because the brain is more able to concentrate. After a whole night's sleep, students who study mathematics in the morning hours at the school benefit from a rested and rejuvenated mind and perform well on quizzes and final exams. This energy allows them to concentrate better on what they are learning and assimilate the information more quickly. This study aims to determine the impact of time of day on learning Mathematics by examining the optimal time of day to teach mathematics in a high school setting. A reasonable timetable can be created. Subjects that demand more concentration and alertness should be scheduled in the early morning hours when the student’s mind is fresh after a night sleep. The objectives include:

- To analyse the substantial difference in students learning accomplishments in Mathematics classes when held in 1st session (morning) and 2nd session (Evening)

Mathematics is a vital and challenging topic requiring a particular level of cognitive attention to grasp its concepts and approaches. The research aims to see how the time of day influences the teaching/learning process. The findings of this study are expected to assist educators to generate a favourable learning atmosphere for pupils by adjusting the time-of-day element.

[1] Waxman, Hersholt C., and Herbert J. Walberg. "Teaching and productivity." *Education and Urban Society* 18, no. 2 (1986): 211-220.

[2] Wolfensberger, Balz, and Claudia Canella. "Cooperative Learning about Nature of Science with a Case from the History of Science." *International Journal of Environmental and Science Education* 10, no. 6 (2015): 865-889.

[3] Aziz, Zahara, Norazah Mohd Nordin, and Md Hossain. "Effects of Cooperative Learning and Conventional Teaching on Mathematics Achievement in Poal Shura Patpara High School." *International Journal of the Humanities* 8, no. 2 (2010).

[4] Najmonnisa, Mirza Aminulhaq, and Ismail Saad. "Impact of Cooperative Learning Teaching Methods on 7th Grade Students' Academic Achievement: An Experimental Study." *Journal of Elementary Education* 26, no. 1 (2015).

LITERATURE REVIEW

Learning of Mathematics

The term "Learning of Mathematics" refers to the proficiencies of understanding, fluency, problem solving and reasoning that are fundamental to learning mathematics and working mathematically and are applied across all three strands Number and Algebra, Measurement and Geometry, and Statistics and Probability[5]. The mathematical abilities of students have a significant impact on a student's learning experience. There is a direct link between parental expectations and their children's math involvement[6]. Students' perceptions of what is valuable in math significantly affect their performance, and their perceptions frequently alter the cognitive resources accessible to them during studying.

Prior experience often dictates which knowledge students consider relevant, and evidence suggests that students believe they can master the subject if they work hard enough. Many people; however, appear to expect homework and problems to be completed in less than twelve minutes; any longer, and they believe it is impossible. The study conducted by Çelik (2018) shows that attitudes of students toward arithmetic and mathematicians are highly fixed, and this has a significant impact on how successful or nervous they are[7]. Students' opinions about what is valuable in arithmetic substantially affect their performance, and their beliefs frequently change the cognitive resources accessible to them during studying. Prior experience typically influences which knowledge students believe is essential, and data shows that students believe they can master the topic if they study hard enough.

Effect of Class Timing on Students' Performance in Mathematics Learning

Reviewing the related literature to explore the possible impact of Time-of-Day instruction on students' achievement, Wile and Gary (2011) found that the increased mathematical learning of students could be achieved when students are taught and assessed at their preferred time-of-day[8]. The findings of the study conducted by Hines (2004) reveal the same results that the increased mathematical learning of students could be achieved when students are taught and assessed at their preferred time-of-day[9]. On the other hand, the study conducted by Manaligod, et al., (2021), while examining the difference in mathematics scores between the morning and afternoon classes, reveals that no significant difference between the morning and the afternoon class timings.[10]

[5] Voskoglou, Michael Gr, and Abdel-Badeeh M. Salem. "Benefits and Limitations of the Artificial with Respect to the Traditional Learning of Mathematics." *Mathematics* 8, no. 4 (2020): 611.

[6] Panaoura, Rita. "Parental involvement in children's mathematics learning before and during the period of the COVID-19." *Social Education Research* (2021): 65-74.

[7] Çelik, Halil Coşkun. "The effects of activity based learning on sixth grade students' achievement and attitudes towards mathematics activities." *EURASIA Journal of Mathematics, Science and Technology Education* 14, no. 5 (2018): 1963-1977.

[8] Wile, Amanda J., and Gary A. Shouppe. "Does time-of-day of instruction impact class achievement?." *Perspectives in Learning* 12, no. 1 (2011): 9.

[9] Hines, Carolyn B. "Time-of-day effects on human performance." *Journal of Catholic Education* 7, no. 3 (2004):

[10] Manaligod, Hector, Veronica R. Gamboa, Norman G. Lee, and Lamberto Ongkingco Jr. "The Effect of Class times on the Academic Performance of Students in Mathematics." *IJASC* 3, no. 3 (2021): 1-7.

Davis (1987) controlled a yearlong report analysing season of-day impacts on understudy accomplishment[11]. It observed that understudies educated in perusing during the last time of the day had a more significant number of gains than those trained in perusing during the primary time of the day. In a comparative report, Davis (1987) observed that the above outcome was not something very similar for math. The general yearly mathematical accomplishment of the understudies is still up in the air by whether they had math guidance in the first part of the day or the evening. One learning about science and season-of-day impacts is inadequate, and more exploration along this request line could prompt more valuable ends. Davis (1987) concentrates on analysing various gatherings of eighth-grade understudies who have told various times. This review adds to this writing by analysing a solitary gathering of 3rd-grade understudies to check whether they perform contrastingly in math at various times. This review incorporates making it more straightforward for educators to carry out the discoveries of cerebrum research in homeroom guidance. Educators who apply cerebrum research procedures to guidance might observe that their understudies advance effectively, giving more educational opportunities to dominate principles. In a more extensive setting, the instructive local area could guide the instructor's focus toward best practices acquired through an assessment of this review.

Davis (1987) second review looked at the hour-of-day impact on science guidance. He analysed season of-day consequences for the guidance of eighth-grade understudies in areas of math. For the school year, understudies have doled out to either first-period science between 8:10 a.m. to 9:10 a.m. or last period science between 1:00 p.m. and 2:00 p.m. The arithmetic educator was unaltered in both of these science classes. The Comprehensive Test Basic Skills was utilised as a pre-test and again as a post-test nine months after the fact. Davis found "the way that there was no clear contrast in accomplishment among morning and evening math bunches is fascinating and more challenging to decipher. Davis closed potentially math involves an equilibrium of short memory and long haul memory along these lines does not fall into a short memory or long haul memory task. Subsequently, learning arithmetic did not stringently fall into an ideal day season.

Callan presumes that season-of-day learning inclinations affected mathematical test execution in this example of 10th-grade understudies. Morning-favoured understudies seem to enjoy a particular benefit when tests have given toward the beginning of the day. The outcomes are less clear for understudies who like to study in the early evening or evening. Morning-favoured understudies score higher than understudies with different inclinations do. This finding suggests that understudies with other season of-day inclinations are in a difficult situation. Callan recommends that this might be valid for such high-stakes tests as the SAT-1, which has offered at 8 a.m. He presumes a requirement for additional exploration to investigate inconsistencies in the grades of similarly capable understudies to decide whether season of-day inclinations may affect results[12].

Caine calls attention to taking neuroscience into the homeroom is testing since we cannot depend solely on mind research[13]. Individuals are excessively complicated, people excessively special, and settings excessively flighty. Incorporating cerebrum research with other examinations and with a sufficient model for guidance, in any case, can furnish instructors with an intelligible

[11] Davis, Zephaniah T. "Effects of time-of-day of instruction on beginning reading achievement." *The Journal of Educational Research* 80, no. 3 (1987): 138-140.

[12] Ibid.

[13] Gülpinar, Mehmet Ali. "The Principles of Brain-Based Learning and Constructivist Models in Education." *Educational Sciences: Theory & Practice* 5, no. 2 (2005).

starting point for outstanding education. This survey gives a more extensive perspective on the most proficient method to apply mind examination to rehearse in the homeroom during a season of day. The impact of the season of day on memory has been dissected. Second, the impact of the season of day on consideration is analysed. Then, season of-day impacts on long haul educational accomplishments have been evaluated.

Maths Effects

For specific years, specialists have been keen on the hurtful results of number juggling on students' numerical accomplishments. Richardson and Woolfolk featured how a few parts of math, like exactness, rationale, and an emphasis on critical thinking, could cause nervousness in specific individuals[14]. Number-crunching nervousness has negatively affected math execution and achievement in examinations[15]. A few researchers have likewise recommended that numerical tension assumes a part in noticed orientation disparities in number related accomplishment and course enrolment patterns, different parts of math uneasiness stand out[16]. In any case, the multidimensionality of math uneasiness has not been enough tended. Research studies revealed two parts of test tension, concern and emotionality, in the space of test nervousness[17]. Stress is the mental part of the tension, and self-decisive contemplations around one's presentation portray it.

Emotionality alludes to the emotive side of nervousness, which incorporates uneasiness, strain, and disagreeable physiological reactions to attempting circumstances. Morris and Liebert exhibited that these two parts of tension are experimentally discrete, regardless of their relationship. That worry is more emphatically connected to unfortunate test execution than emotionality (for any work on stress and emotionality). Scholars feel that test nervousness, worry or mental part is the most negative to achievement[18]. Most math uneasiness research has been finished with secondary school and undergrads, so little is had some significant awareness of its pervasiveness among more youthful individuals. The restricted investigations of math nervousness in more youthful understudies uncover that, similar to test uneasiness, math tension increments with age[19]. We additionally could not say whether there are distinctions in sexual orientation in numerical nervousness among more youthful students. At the same time, young men have somewhat more ideal sentiments about math than young female students in elementary and middle school do. Female understudies express more juggling tension than male understudies do during their secondary school and school years. Kirsti (2019) concluded that distinctions in sexual

[14] Richardson, Frank C., and Robert L. Woolfolk. "Mathematics anxiety." *Test anxiety: Theory, research, and applications* (1980): 271-288.

[15] Morgan, Patricia, and Dor Abrahamson. "Contemplative Mathematics Pedagogy: Report from a Pioneering Workshop." In *Annual Meeting of the American Educational Research Association*. 2019.

[16] Abrahamson, Dor, and Patricia Fay Morgan. "Educational Design of Mathematics Content: Report from a Pioneering Workshop." *The Journal of Contemplative Inquiry* 5, no. 1 (2018).

[17] Putwain, David W. "An examination of the self-referent executive processing model of test anxiety: control, emotional regulation, self-handicapping, and examination performance." *European Journal of Psychology of Education* 34, no. 2 (2019): 341-358.

[18] Barroso, Connie, Colleen M. Ganley, Amanda L. McGraw, Elyssa A. Geer, Sara A. Hart, and Mia C. Daucourt. "A meta-analysis of the relation between math anxiety and math achievement." *Psychological Bulletin* 147, no. 2 (2021): 134.

[19] Assmus, Daniela, and Torsten Fritzlar. "Mathematical creativity and mathematical giftedness in the primary school age range: an interview study on creating figural patterns." *ZDM–Mathematics Education* 54, no. 1 (2022): 113-131.

orientation in numerical nervousness were more significant and more far-reaching than grade-level contrasts[20].

Methodology

Research Strategy

The authority of math is a crucial proficiency part that affects youngsters' progress in schooling and future society[21]. The attention to math learning and math capacity advancement has been an intermittent point in instructive and mental examinations for 100 years[22]. The school system advances the prerequisite of planned exercise of accessible assets and the better thought of the day on the learning system to accomplish expanded proficiency, usefulness, and adequacy. This review utilises a primary way to deal with investigating and responding to the examination question; it takes two classes VII section E and F; class VII segment E is the gathering that is granted the subject of math during the evening through class VII segment F is the gathering that is conferred the subject of arithmetic during morning hours when the understudy's brains are ready. Concerning the system of this review, they expect that the day of the week does not impact the time for information assortment. They likewise accept that the tests I planned give a reasonable estimation of training on a formerly mastered ability instead of testing their improvement in the expertise of expansion.

The objective of this new review is to investigate the efficiency of learning of the understudies and to gauge the quality of the season of day of showing science and how much the hour of day influences the learning accomplishments of understudies and is helpful to the instructors in choosing different showing methodologies and strategies according to favoured learning season of arithmetic for the understudies. The issue under study, for this situation, is figuring out what is the impact of controlling season of day investigation of showing arithmetic understudies' learning execution and accomplishments. The hour of the day of showing science is a device that influences understudies' capacity for learning. It says that understudies who concentrate on arithmetic in the first part of the day yield preferable outcomes to those who study in the early evening. This is because at the beginning of the day mind is new, and students have better focus before noon at night time of rest when contrasted with in the early evening. Students' test results could be raised basically by revamping the plans, which could be a savvy way for schools to support their outcomes.

The exploration utilised the science after effect of grade 7 understudies of a Karachi-based school subsidiary with Aga Khan University Examination Board Karachi. The composed authorisation was accomplished by the school and guardians of understudies for their information assortment and investigation. Two segments of grade 7 (Section E and F) were noticed for their consequences of Mid Term and Final Term. Class VII-E understudies had arithmetic class directed in the early evening time while class VII-F understudies had their class in the first part of the day; understudies'

[20] Kislenko, Kirsti. "11.'Mathematics is a bit difficult but you need it alot': estonian pupils'beliefs about mathematics." *Beliefs and attitudes in mathematics education: New research results* (2019): 143.

[21] Engle, Patrice, Sally Grantham-McGregor, Maureen Black, Susan Walker, and Theodore Wachs. "How to avoid the loss of potential in over 200 million young children in the developing world." *Child Health Educ* 1, no. 2 (2007): 68-87.

[22] Geary, David C. "Development of Mathematical Understanding." *Handbook of Child Psychology* 2 (2007).

roll numbers and names were utilised in the review was no blinding practice. At the same time, understudies' viewpoints about this exploration question were assembled utilising surveys.

Targeted Population

The targeted population of this study were high school students, and we selected two classes, VII sections E and F, as a random sample from this group. The sample size was a portion of the population chosen in a survey or investigation. We conducted a poll on smartphone users' brand preferences. It was a good depiction of anyone who chooses the sample carefully. In statistics, a sample is a percentage of the overall population. The sample of this study included a randomly selected school in Karachi having VII grade with sections E and F. The school was associated with the Aga Khan Board. The population can be concluded as a whole using data from a sample. A sample's standard deviation, for example, can be used to approximate the population's standard deviation. Finding a sample size was one of the most challenging tasks in statistics. It is determined by various criteria, including the size of your original population. This study's data examined the use of a variety of statistical approaches, including descriptive statistics. The sample size for this study may be sixty-two (N=62).

Hypotheses

The research hypotheses of this research study are focused on finding out the meaningful relation between time of day and learning achievements in mathematics.

H1: There is a statistically strong and positive relationship between the time of day and students' learning achievements

H3: Time of learning affects the mathematical learning of students.

Research Instrument

Classroom polls were used to obtain data for this research study. The poll's question is, "Should mathematics be taught in the early hours of the day?" There are four alternatives in this poll including Agreed, Disagreed, Maybe, and Do not know. Data submitted in the form of students' mathematics grades and classroom surveys asking students about their preferred time of day for the topic of mathematics.

Data Analysis Procedure

SPSS software was used to analyse the data. The information was gathered from classroom polls. Data obtained from classroom polls and observations of classroom results under observation can be deduced that students who are taught mathematics in the early morning hours have better learning outcomes than students who are taught mathematics in the afternoon. As a result, the collected data clearly shows that the hypothesis is valid.

Results & Findings

Descriptive Statistics

Data was submitted in the form of students' mathematics grades, as well as classroom surveys asking students about their preferred time of day for the topic of mathematics. SPSS software was used to analyse the data. The information gathered from classroom polls is presented below:

Table 1: Data Collected from Classroom Polls

Class	Agreed	Disagreed	Maybe	Don't Know
Class VII section 'E'	20	7	3	1
Class VII section 'F'	27	1	2	1

Data Interpretation

This can be deduced from data obtained from classroom polls and observations of classroom results that are under observation: students who are taught mathematics in the early morning hours have better learning outcomes than students who are taught mathematics in the afternoon. As a result, the collected data clearly shows that the hypothesis is valid. The population of this study is high school students, and we selected two classes VII sections E and F as a random sample from this group. In a survey or investigation, the sample size is a portion of the population chosen. You could, for example, conduct a poll of smartphone users' brand preferences. You won't want to poll all of the country's millions of smartphone owners (either because it's either expensive or time-consuming), so you'll employ a sample size. There may be tens of thousands of owners. The sample size reflects the brand preferences of all dog owners. It will be a good depiction if you chose your sample carefully.

In statistics, a sample is a percentage of the overall population. This study's sample is drawn at random from a Karachi based school's class VII section E and F, which is associated with the Agha Khan Board. You can conclude a population as a whole using data from a sample. A sample's standard deviation, for example, can be used to approximate the population's standard deviation. Finding a sample size is one of the most difficult tasks in statistics, and it is determined by a variety of criteria, including the size of your original population. This study's data was examined using a variety of statistical approaches, including descriptive statistics. The sample size for this study is sixty-two (N=62).

Math is never a difficult subject to learn if the new information is presented at the optimal time for pupils in that subject. This study looked into the time-of-day-based study of mathematics and found that it is critical to take these preferences into account when teaching and learning methods evolve. The student's exam performance can substantially increase if learning is done at the appropriate time for that subject.

The findings reveal that afternoon classes lower mathematic test scores, which relates to psychology and neuroscience research on brain activity at various times of the day.

- This study illustrates that there is a relationship between time-of-day and the learning achievements of students

- This study also shows that there is an impact of time-of-day on students' performance in mathematics

Conclusion

It is the teacher's responsibility to recognize that a student's learning ability in the subject of mathematics is time-dependent and that rearranging school schedules more optimally does not require an investment of unnecessary resources and could be a cost-effective involvement that leads to improvements in students' academic performance in the subject of mathematics. According to research on learning styles, when a student is taught and graded during their preferred time of day, they learn more. To find the ideal time of day for some core disciplines, more research is required. My suggestion is that classroom polls be performed to determine students' preferred time of day for instruction to optimize the teaching/learning process. More research needs to be done on this topic to a time-of-day preferences model so that this factor may be effectively utilized in the teaching/learning process. Schools may change their timetables to ensure that as many children as possible take math in the morning.

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