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## Does Time-of-Day of Instruction Impact Class Achievement?

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### Abstract

This article explores literature related to Time-of-Day instruction and possible impact on student achievement for students. The possibility of schools as a contributing factor to the problem of low academic performance by some students due to a conflict between personal chronotype and school schedule may have research significance. In order for learning to take place, student engagement must be paramount and provide optimal opportunities for students to utilize their personal learning, for modalities may hinge on physical readiness as well. Several studies at multiple grade levels related to the investigation of circadian rhythms and biological patterns which indicate an effect on student performance are examined. Learning-styles research reveals increased learning occurs when a student is taught and assessed at their preferred time-of-day. Current research from later-start time initiatives in schools indicates positive outcomes for some students. Collectively, these studies suggest that one strategy to maximize the potential for learning may be consideration of a student's chronotype, the preference to function during certain times of the day.

Are you a morning person or a night person? Different people function more efficiently at different times of day. In educational settings, this can affect whether students are performing at their best during instructional and testing times (Hartley & Nicholls, 2008). Time-of-day when academic subjects are taught could affect student achievement. Millar, Styles and Wastell (1980) claimed morning learning is associated with superior immediate recall when compared to learning in afternoon or evening. However, material initially learned in afternoon is more beneficial to long-term memory recall.

Elementary classrooms normally teach core academic subjects, such as reading and mathematics, during morning hours prior to lunch. High school class schedules are randomly assigned to students, and therefore, students have core classes at various times of day. Since time-of-day for most high school classes is assigned by chance, students may not be learning at their optimal times. Teacher workroom

conversations often center on how to motivate students in afternoon classes, and teachers consistently report their afternoon classes are harder to teach (Sjosten-Bell, 2005).

Circadian rhythm is a 24-hour cycle in biochemical, physiological, or behavioral processes of people. Circadian rhythm influences the store and retrieval of information (Davis, 1987a). These rhythms also affect cardiac function and body temperature (Klein, 2001). As early as 1925, researchers have found that time-of-day impacts task performance. In 1971 this view was espoused:

Blake related these fluctuations to changes in body temperature. He found that our basal arousal level (essentially, a measure of mental alertness) and body temperature starts to increase upon waking and, with the exception of a dip after noon, continues to rise until about 8:00 P.M. According to Blake, when body temperature is high, so is arousal and

## TIME-OF-DAY INSTRUCTION

high arousal may interfere with short-term memory (as cited in Sjosten-Bell, 2005, p. 13).

Studies show higher arousal benefits long-term memory more than in short-term memory (Millar et al., 1980). Biorhythms affect one's ability in mental, physical, and emotional activity over a period of time. Biorhythm cycles oscillate in a steady wave and last 23 to 33 days. Basic plasma hormone levels due to circadian rhythms promote arousal from a low level in early morning to a peak in evening (Davis, 1987a). According to the Mayo Clinic, more than 100 human functions are impacted by hormone changes due to biorhythms and circadian cycles (as cited in Klein 2004). These physiological and biochemical changes in a person express themselves in daily fluctuations affecting time-of-day for learning and recall.

Research indicates the left hemisphere of the human brain dominates in morning hours giving humans best processing of data, short-term memory and routine (Davis, 1987a). Linear reasoning, numeric manipulation, arithmetic skills, mathematical concepts and language functions such as grammar and vocabulary are all related to left hemisphere functions. Typically, right-handed people dominate in preference over left-handed people. Nevertheless, most right-handed people show left hemisphere dominance. Research has shown right-handed students perform better in morning and tenth graders had increased concentration during morning hours (Klein, 2001).

The right hemisphere is dominant in afternoon hours allowing for processing of visual information and long-term memory (Klein, 2001). Processing of visual and audiological stimuli, spatial manipulation, facial perception and artistic ability seem to be right hemisphere functions. Left-handed people for majority dominate in right brain

functions. In addition, left-handed children perform better in afternoon hours.

Researchers also suggest gifted people do better in afternoons, and children who have difficulty in reading would perform better in afternoon hours (Klein, 2001). Klein (2001) found fifth graders' attention levels were higher in afternoon settings. In multiple studies when compared to material learned in morning hours, material originally learned in afternoons show advantages for long term recall (as cited in Millar et al., 1980).

Student achievement in reading is shown in several studies to be influenced by time-of-day of instruction. These studies show an increase in reading achievement for students is more likely if students receive instruction in afternoon rather than instruction in early morning. This is because reading comprehension entails connecting information presented in text to relevant prior knowledge by a reader (Davis, 1987a). Reading comprehension is a process relying on long-term memory. Davis' (1987a) study investigating reading comprehension found beginning readers who received afternoon reading instruction generally achieve at higher levels. The study showed first period instruction was usually less beneficial than last period instruction in development of first grade students. This study was performed over a period of one school year in reading achievement differences based on the Comprehensive Test of Basic Skills. Davis' (1987b) second study with eighth grade students in English confirmed those who received English instruction in afternoon achieved higher than morning groups. In 2004, Klein found learning achievement for middle school students in literature was best between 11:00 A.M. and noon followed by another peak between 1:00 P.M and 2:00 P.M. Because reading skills are developed over a substantial period of time, most skills used in reading rely on accessing long-term

memory which shows advantages in afternoon. Klein's (2004) results confirm reading achievement is best in early afternoon, and therefore, these findings speak in favor of having reading instruction in afternoon rather than morning.

Davis' (1987b) second study looked at time-of-day effect on mathematics instruction. He examined time-of-day effects on instruction of 80 eighth grade students in areas of mathematics. For the school year, students were assigned to either first period mathematics between 8:10 A.M. to 9:10 A.M. or last period mathematics between 1:00 P.M. to 2:00 P.M. The mathematics instructor was unchanged in both of these mathematics classes. The Comprehensive Test of Basic Skills was used as a pretest and again as a posttest nine months later. Davis found "the fact that there was no apparent difference in achievement between morning and afternoon math groups is interesting and more difficult to interpret" (p. 79). Davis concluded possibly mathematics entails a balance of short-term memory and long term memory therefore does not fall into a short-term memory or long-term memory task. Consequently, learning of mathematics did not strictly fall into an optimal time-of-day.

Sjosten-Bell (2005) tested 20 third grade students with a series of quizzes during three different time periods in a day (morning, mid-morning and afternoon) over a three week period. Quizzes included ten similar addition problems in order to test an already-learned skill from students' long-term memory. Results found a slight trend toward students performing best in morning. However, results did not show a statistical significance between student scores on quizzes and time-of-day assessed.

Using a questionnaire to study self-assessed levels of attention in fifth and tenth grade students, Klein (2001) examined mathematics aptitude and levels of attention.

He found levels of attention were highest in afternoon and lowest in morning for fifth grade students no matter what their mathematical aptitude level determined by students' yearly mathematical aptitude tests. He then found levels of attention for tenth grade students were lowest in afternoon and highest in morning. Mathematics aptitude was correlated with perceived levels of attention. However, research is not clear if academic subjects were being studied during different times of day in this study. Different subject matter during students' self-perceived periods of higher attention could have been more interesting or favored which would explain their attention level being heightened. Also, the self-assessed questionnaires were filled out for only one day. Higher levels in attention could have shifted to different times-of-day depending on more attention-grabbing classroom activities and lessons on one particular day.

Several studies have found that students perform better during a particular optimal time of day. Goldstein, Hahn, Hasher, Wiprzycka, and Zelazo (2007) found approximately a six-point difference in Full Scale IQ equivalents between an individual's circadian arousal pattern and time of testing. Holloway (1999) reported that students scored better during their teacher's optimal time of day. This suggests student learning is influenced by teachers' time-of-day preferences as well as individual student time-of-day preferences. Research was conducted in the UK determining whether college students performing at a preferred time-of-day would show better achievement in morning, intermediate or evening hours. Students who preferred morning and intermediate times-of-day outperformed those who chose evening times-of-day in regard to scores on exams. However, scores for students preferring morning and intermediate times-of-day were not significantly different

## TIME-OF-DAY INSTRUCTION

(Hartley & Nicholls, 2008). In a dissertation study, Lynch (1981) found greatest influence on reduction of truancy resulted from matching the time preferences of students with their English course period schedules. Virostko's (1983) dissertation research related to mathematics achievement over a two year period in an elementary setting, found 98% of students scored higher if material was learned during a student's optimal time-of-day.

Most research has found time-of-day does play a significant part in student achievement. When students were taught at times matching their learning style preferences, scores were significantly higher on achievement tests. If time is viewed as a resource and can be influenced to support high quality instruction, preferred time-of-day is much more likely to result in improved learning (Johnston, 2009). However, not all students performed best at one particular time-of-day. Currently, schools are not set up to match every student's optimal time-of-day preferences. Therefore, there is a need for research showing optimal time-of-day for particular subjects with a maximum number of students.

Research is needed to determine the best time-of-day for certain core subjects as a whole. Currently, educational climate for high school requires 32 to 36 students in a classroom making it difficult to meet every student's individual needs. If most students perform better in reading during afternoon hours and mathematics during morning hours, class schedules should be matched to meet learning requirements of more students. The authors' motivation to conduct research projects related to time-of-day of instruction on class achievement for students is to discover how to best use acquired data to influence student achievement in academic settings and is beyond the scope of this article.

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