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Northard, Amanda C. ***The Impact of Class Schedule on Student Learning in a Middle-Level Computer Science Classroom***

Abstract

This study sought to determine if there was a relationship between class time length, schedule type and student academic performance on student learning at Middle School A, a suburban 7th and 8th grade school in southeast Wisconsin. Between 2017 and 2021, the school transitioned between three different schedules, most recently adopting a 96-minute block. Data from these four school years are compared using a one-way ANOVA on the average grade point average and end of quarter assessment scores in the Introduction to Computer Science course. Findings revealed that the average GPA dropped each year from 2017 to 2020, but it rebounded slightly in 2021, when the block schedule was implemented. However, scores for the Introduction to Computer Science end of course assessments dropped each year. In both cases, the most significant drop was in 2020, when Middle School A implemented virtual learning for eleven weeks learning because of COVID-19. While the scores decreased over the time, it is unclear whether schedule length affected this because of the many effects of the pandemic on the learning environment.

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Chapter I: Introduction

Education in the United States constantly changes and adapts to better serve the needs of students. Since the 1990s, public school districts have modified and adjusted schedules to give teachers more time to integrate cross-curricular activities, allow for discussion and increase depth of knowledge (Small, 2000). Traditionally, high school and middle school schedules have students attend between six and eight class periods daily, with most classes meeting for an hour or less. An alternative to this is the block schedule, sometimes called a 4x4 schedule, divides the time equally between four classes, allowing for each period to be between 80 and 90 minutes (Zepeda & Mayers, 2006). The block schedule expands class time into fewer but longer periods, which allows more flexibility with instructional activities (Northeast and Islands Regional Educational Laboratory at Brown University, 1998).

Block scheduling includes a series of benefits and disadvantages in the classroom that can be applied to Career and Technical Education (CTE). The hands-on nature of CTE classes benefit from more time; less class time is wasted in set-up and clean-up of labs. Additionally, the reduced number of students allow for teachers to integrate and align concepts between core classes and electives (Small, 2000). However, students with short attention spans struggle to focus for the entire class, especially those with disabilities (Santos & Rettig, 1999).

Middle School A, a suburban middle-level school that serves about 750 students annually in southern Wisconsin, was the focus of this study. High School B, the 9^{th}-12^{th} grade school that Middle School A feeds into, switched to a modified block schedule in 2018 called a “Drop Three.” Students take eight classes during the semester and attend five classes each day; each class meets three times a week for an hour and fifteen minutes. See Appendix A for a detailed layout of High School B’s block schedule. The transition was made to allow students to take

more elective courses; with the previous schedule, students only had seven classes per semester (S. Blue, personal communication, January 18, 2021).

Statement of the Problem

Between 2017 and 2021, Middle School A has used three different class schedules for students and teachers (L. Liebecke, personal communication, January 14, 2021). In the 2017-18 school year, English and Language Arts, science and social studies classes increased to 96 minutes, with all others having 56 minutes. Because this reduced social studies and science to one semester each, the community felt these courses were not given enough merit in the schedule (L. Liebecke, personal communication, January 14, 2021). In 2018-19 and 2019-2020, all classes were reduced to 46 minutes to accommodate daily science and social studies, though English and language arts stayed at 96 minutes.

In 2020, Middle School A switched from an eight-period schedule to a 96-minute four-period block schedule. The purpose of this was to reduce the spread of COVID-19 in school. Five lunch periods were needed to decrease the number of students in the cafeteria and with students only attending four classes a day, the number of peers they see is limited (L. Liebecke, personal communication, January 14, 2021). The number of transition times between classes was reduced from nine to six so students could not gather in the halls, though the length remained the same.

The schedule change has affected exploratory and elective classes, including CTE courses, when it comes to transitions and class time. In the 2017-18 school year, quarter-long classes met 45 times for 56 minutes, for roughly 42 hours in total. Then, in 2018-19 and 2019-20, these courses met the same number of periods, but the length was reduced to 46 minutes, for a total of 34.5 instructional hours, a loss of seven and a half hours of class time. Finally, in 2020-

2021, classes met every other day for 96 minutes, bringing the total time to a little over 35 hours. The middle school schedule has been discussed many times, but data has never been analyzed to support a move to one option or another. It is unclear how recent changes in the middle school class schedule has influenced student performance.

Purpose of the Study

The purpose of this study was to determine if there was a relationship between class length and student achievement. Specifically, it focused on the effect of three different schedules used in Middle School A, a suburban school district in southern Wisconsin between 2018 and 2021.The following questions guided this research:

1. What effect does the number of instructional minutes have on student performance?
2. Did meeting daily versus alternate days affect retention of information as indicated by student performance?
3. Which schedule had the strongest student performance?

Significance of Topic

The national CTE research agenda includes many facets including instructional strategies, best practices, and quality of instruction (Wonacott, 2002). The length of class and course meeting schedule directly affects how a teacher leads instruction and structures their class. Hands-on activities and labs essential to CTE courses can be difficult or impossible to fit into shorter class periods.

Additionally, improving student learning is the goal of all teachers. The school district that includes Middle School A and High School B puts student learning as top priority. Superintendent Shawn McNulty (n.d.) stresses in his Superintendent's Message that district schools "create positive school climates where all students can be successful." Block scheduling

creates more time for students to spend in the same class, allowing teachers to plan for more collaborative and diverse learning activities (Lewis et al., 2005). Vygotsky's (1978) sociocultural theory of human learning stresses the importance of social interaction when learning; students learn better when interacting with other people, instead of in isolation. While teachers may already use collaborative learning in their classroom, the increased class time may allow for more opportunities to utilize this strategy.

Research into block and traditional schedule was popular in the late 1990s and early 2000s but has diminished in the last decade. Many of the research studies during this time had inconclusive results, but nearly all urge for more research to be done (Zepeda & Mayers, 2006). Because Middle School A has dabbled in both traditional and block scheduling over the last four years, it provides a unique opportunity interrogate student performance from different schedules on the same course and similar set of students.

Methodology

Two sets of ex post facto data were used and compared between the two schedule types: traditional daily classes and alternating block schedule. The first set of data consisted of the quarterly grade point average (GPA) for all students in Middle School A for each grading period from 2017-2021. The second was specific to Introduction to Computer Science. Students were given end of course tests to evaluate their understanding of learning targets throughout the quarter-long class. All identifying information has been removed from the data to preserve privacy. These data sets will be compared between the different schedule types, traditional and block schedule, to determine if there is a significant difference in GPA and end of quarter test results.

Definition of Terms

Common terms used in this paper are described in this section.

4x4 Block

A scheduling system in which students take four courses per semester, meeting daily between 80 and 110 minutes. An entire year's worth of curriculum is compacted into this semester course (Always Be Learning Inc., 2018).

A/B Block Schedule or Alternating Block

A schedule in which students take eight courses for a school year. School days alternate between two different class sets; students meet with each of their eight classes every other day instead of daily (Always Be Learning Inc., 2018).

Block Schedule

The scheduling system used in schools to divide time between fewer classes; periods are longer but meet less often. Block schedule periods are often at least an hour and fifteen minutes in length (Always Be Learning Inc., 2018).

Introduction to Computer Science

The course the data was collected from for this study, including pre-, mid- and end of quarter assessments. The curriculum written for 45 class periods of 45 minutes each and covers the basics of computer programming and algorithms (Park View Middle School, 2021).

Middle School A

The middle school the data will be collected from. Middle School A is the only middle school in the school district and serves nearly 800 students in grades seven and eight (Mukwonago Area School District, 2021).

Traditional Schedule

The scheduling system used in schools that meet with seven or eight classes during a day. Classes in a traditional schedule are usually around 45 minutes in length (Unlocking Time, 2018).

Limitations of the Study

This study is limited by the following:

1. **transference:** The study is limited to one suburban middle school. The results may not transfer to other schools.
2. **limited diversity:** Middle School A is a suburban school in Wisconsin with little diversity. Results may differ in urban or rural schools with a more diverse population.
3. **limited data:** One semester of end of quarter assessments is missing in the data: Spring of 2020. COVID-19 closed schools nation-wide and the Introduction to Computer Science course was delivered in an entirely online, asynchronous manner. The end of quarter assessment was not given.

Chapter II: Literature Review

Ever since unified public education started in the United States, the educational system has constantly been adapting to fit local and national needs and requirements. The modification of class times and schedule is no exception. This literature review will explore the evolution of schedule types as well as the advantages and disadvantages of the block schedule.

Historical Context

Despite the evolution of everything around it, education changed very little first half of the 20th century. Starting in 1906, most high schools operated using the Carnegie Unit, a schedule that allocated 120 hours per year for a specific course; these hours could be split as the schools saw fit, but fourteen units were considered four years of high school academics (Carnegie Foundation for the Advancement of Teaching, 2014). Very little changed from this organization for secondary schools until 1983 when Ronald Reagan's Secretary of Education, Terrel H. Bell, released a report – A Nation at Risk. Several factors were identified as problems in the report, including that a large portion of American adults were functionally illiterate, the steadily declining SAT scores, and students entering the workforce without critical thinking skills (National Commission on Excellence in Education, 1983). In no uncertain terms, it addressed foreign powers overcoming the advancements that the United States had made in science, technology, and commerce, claiming "history is unkind to idlers" (National Commission on Excellence in Education, 1983). To stay competitive on the world stage, the Department of Education pushed for reform and evolution.

A decade later, a new report was released by Department of Education: Prisoners of Time. This report shifted focus not on what was being taught in the classroom but focused instead on how time was being used in the school day. Instead of increasing the length of the

day, schools were encouraged to focus on how time was structured for students to maximize learning (National Education Commission on Time and Learning, 1994).

Manipulating and modifying the class schedule was an idea put forward by administrators and educational researchers to improve student achievement (Santos & Rettig, 1999). Prior to this, most schools had the same type of schedule, usually called the traditional schedule; students attended between six and eight different classes throughout a school day, usually between 35 and 50 minutes (Gruber & Onwuegbuzie, 2001). The block schedule was introduced as an alternative to this abundance of courses in a day.

Block Scheduling

In a block schedule, students would attend only four classes in a day, increasing the period length to be between 80 and 110 minutes, depending on the school (LAB at Brown, 1998). The two most common block schedules were the A/B Block and the 4x4 Block. The two share the fundamental idea that the class period should be lengthened but the major difference was the number of courses a student would focus on in a semester. In a 4x4 block, students take only four classes at a time meeting daily for half the year, while a A/B schedule alternates between two different schedules of four classes meeting every other day for the full year (Unlocking Time, 2020).

By the early 2000s, it was estimated that nearly 50% of US high schools had implemented some sort of block scheduling (Lewis et al., 2003). For the school year of 2003-2004, the National Center for Education Statistics (2004) reports that 34.5% of high schools used block scheduling, with schools on the east coast being more likely to utilize it than those in the mid-west and west coast.

Advantages of Block Scheduling

Research and teachers are quick to point out the advantages of lengthening class time. In a traditional schedule, teachers could have five or six different classes to plan for. Canady and Rettig (1995) go into this further about the traditional schedule:

> High school teachers are under tremendous stress simply trying to deal with large numbers of students passing through their classroom each day. As a result, many teachers report they are unable to teach more effective, active learning methods; in the interest of survival, instructional compromises are made. (p. 2)

With a longer period, teachers can encourage these active learning strategies and student involvement such as class discussions, cooperative learning, and peer coaching (Jenkins et al., 2002; Lewis, Dugan & Winskur, 2005; Zepeda & Mayers, 2006).

Students also have positive perceptions of block scheduling after experiencing it. Fifty-three percent of students reported the block scheduling has reduced their stress; 42% felt they received more individual help if they had questions (Veal & Finders, 2001). Additionally, both students and teachers report that the school climate has improved by switching to block. Because more time is structured and supervised, behavior problems decrease (Lewis et al., 2003; Pisapia & Westfall, 1997). Students, when surveyed, replied positively about block scheduling, in claiming to have more time for work in class and the ability to focus on fewer classes at a time (Zepeda & Mayers, 2006).

Nearly all literature mentions block scheduling helps foster positive relationships between students and teachers. Students felt their teachers knew them better and cared about them more than those in a traditional schedule (Veal & Finders, 2001). Administrators reported that behavior management skills by teachers improved because the classroom climate improved

(Lewis et al., 2003). With more time, teachers can understand their students more; there is only so much one can do when seeing six to seven different groups of students in a day.

Teachers also embrace the block schedule to help alleviate some of their own stress (Canady & Rettig, 1995). In addition to less classes to prepare for in a day, teachers are provided more time to collaborate with other teachers, whether in the same department or across different curriculums (Small, 2000). Longer periods also allowed for more opportunities for professional development. Principals can observe teachers and classes for longer, allowing them to see a wider variety of how class time is used; the extra time also can be used for principals to come in and demonstrate active learning strategies, which was nearly impossible to do in only 45 minutes (Zepeda, 1999). More relaxed teacher with opportunities to improve their skills are better for students and the school environment.

Additional time also allows teachers to integrate technology into their classroom, which can often be an essential part of Career and Technology Education courses. Technology allows students to wide array of information and tools that can foster a deeper understanding of subjects through inquiry and research (Gregory & Herndon, 2010). Integrating technology can take learners from a more passive role to an active one, as a seeker or knowledge, but often these uses require additional time than a normal class period can allow (Means, 1994).

Disadvantages of Block Scheduling

The idea of block scheduling revolves around time and giving teachers more of it to use. Contrary to that, most schools when switching to a block schedule lose time over the course of the year because it is allocated in larger chunks, but in more places (Lewis et al., 2005). Some worry that with this loss of time comes loss of instructional topics, leading to a less rigorous curriculum (Lewis et al., 2003). Advance Placement test scores dropped, which some attributed

to the loss of class time (Pisapia & Westfall, 1997). If the purpose of block scheduling is to improve the quality of workers entering the workforce, lowering the bar of standards does the exact opposite.

While teachers when surveyed claim they can use more varied teaching styles, results say otherwise; despite having additional time to plan and use differing teaching styles, teachers fall back on lecture, using it just as much as traditional courses do (Jenkins et al., 2002). Because of the loss of instructional minutes, teachers feel they need to use lecture to ensure students receive as much information as possible. Despite advocates for block scheduling consistently advocating that teachers can use new and more engaging teaching styles, research does not support the idea that most are (Lewis et al., 2003). Whether this is because of a lack of professional development or the difficulty of change is unclear. The most important factor to ensuring block scheduling is implemented properly is educators must have access to professional development and are willing to adapt (Lawrence & McPherson, 2000). Block scheduling on its own is not a magic solution that suddenly improves learning; teachers must be trained to maximize their instructional time and in the different strategies used to engage learners.

From a student perspective, the only negative feedback given was the difficulty in making up absences (Santos & Rettig, 2003). While students no longer miss more than four classes, the amount of work and instruction lost is increased; especially with extended absences, students have a difficult time making up their missed work (Lewis et al., 2005). Additionally, if teachers are using collaborative learning, which block scheduling is a proponent of, making up the work outside of class means students are missing out on the same learning experience their peers had when present.

Finally, block is a difficult schedule for students with disabilities or ADHD to adjust to. Periods of 90 minutes or more are difficult to focus during for a typical student, but for those with attention problems, it can be problematic (Santos & Rettig, 2003). Continuity is also a major problem; with the nature of block, courses are either alternate days or semesters. Students with disabilities need a consistent approach to help bridge gaps, especially in core subjects like reading and math (Santos & Rettig, 2003). While it does make pulling students out for assistance easier for additional help since they do not miss a whole class period, the other difficulties offset this minor advantage.

Results of Research

While research for block scheduling came in a large wave when it was first popular, it has petered out since the late 2000s. Research collected by Zepeda and Mayers (2006) came to several conclusions: First, students, teachers and administrators when surveyed are positive about the results of block scheduling and its results; however, they are based around topics that are not tangible, including relationship building and behavior management. Second, the results on academic achievement are mixed, at best.

Some studies claim that the grade point average of their students rose with the implementation of block scheduling (Lewis et al., 2003). However, they often fail to mention that the increase was because students were able to take more elective courses such as fine arts, which are often easier to receive good grades in (Pisapia & Westfall, 1997). Overall GPA is a difficult to use to measure the success, since it considers all classes but does not factor in difficulty of course in the calculation nor is it always an accurate measure of understanding.

Lewis et al. (2003) performed a quantitative study on standardized testing results for English and Science, comparing across a traditional, 4x4, and A/B block schedule all in the same

school. While Science scores increased slightly in the block for the lower 50% of students, the upper end did not change. The English scores were much more varied; while the lower 50% increased their scores most, the other half dropped slightly. Ultimately, they concluded that block scheduling, whether 4x4 or A/B, is no worse for academic achievement than the traditional schedule. In a study that solely focused on biology courses, Labak et al. (2020) found similar results; the mid-level students improved while the low- and high-level students were not affected. The goal of block was to ultimately improve the school environment for learning; while finding no improvements is far from detrimental, it is not the result school district and administrators want to hear.

Summary

Unfortunately, the results of the numerous studies in block scheduling and achievement are consistently inconsistent (Lewis et al., 2003; Zepeda & Mayers, 2006). Because there are so many factors that go into a school environment, comparing two different schools on opposite sides of the state can be nearly impossible. What works at one high school may not offer the same benefits at others. Additionally, the difference between urban, rural, and suburban schools means that any solution may not be a magic fix. When comparing students' achievement based on schedule type, the schools with block scheduling had higher scores in suburban and rural areas but the urban schools that utilized this schedule were significantly lower (Poppin, Ma & Shen, 2019). Modifying the schedule is not a one-size fits all solution.

The research in block scheduling all concludes the same way: more research is needed. Recent studies are few and far between. Block scheduling was a hot topic in the late 90s and early 2000s, but dipped when other topics became the new focus, specifically the Common Core Standards and No Child Left Behind. There are few studies after 2010, and even then, none are

related to Career and Technical Education. So, while nearly 35% of secondary schools in the US are using block scheduling, no one knows if the academic implications exist. Even then, nearly all studies revolve around high schools with little information on how block scheduling works at junior high or middle schools.

Chapter III: Methodology

The purpose of this study was to determine if there was a relationship between class length and student achievement. Specifically, it focused on the effect of three different schedules used in Middle School A, a suburban school district in southern Wisconsin between 2018 and 2021. The middle school has utilized three different class schedules, adjusting class time from a 56 minute, seven-period day to a 46 minute, eight-period day. For the 2020-2021 school year, the adopted schedule was a 93 minute, four-period day, alternating between two different sets of four classes. The specific research questions that guided the study were:

1. What effect does the number of instructional minutes have on student performance?
2. Did meeting daily versus alternate days affect retention of information as indicated by student performance?
3. Which schedule had the strongest student performance?

Research Design and Data Collection

This study utilized a quantitative design. To evaluate whether this change in class period time affected student skill mastery, a correlational quantitative study was performed to see if a relationship exists between student performance as reflected in grade point averages and in the end of quarter assessment for Introduction to Computer Science. A quantitative study was used to because the two pieces of data collected were small summaries of student learning over a large group of people. All data used in this study was ex post facto has never been used to compare different scheduling types.

Subject Selection and Description

The population studied was all students at Middle School A. Grade point average data was collected from all students from 2017-2021. A smaller sample was also used of those

enrolled in the Introduction to Computer Science course over a series of the same four years. The end of quarter assessment scores from this course were used to look closer at the effects of scheduling on a specific class. Those represented in the sample were at least 20% of the school population each year.

Introduction to Computer Science is one of four classes in the required exploratory rotation for seventh grade students to complete at Middle School A. However, the first year the course was offered, interested eighth grade students could elect to take it with the seventh-grade students. Additionally, students with scheduling conflicts their seventh-grade year could enroll as eighth graders. The majority of those in the course were seventh grade students.

Instrumentation

Two different pieces of ex post facto data was used to complete this study. For the overall population, the grade point average from all students in Middle School A was exported from Infinite Campus, the district's grading system. Each student was represented by their end of the year GPA. This ex post facto utilized, and the research design was approved by the UW-Stout IRB in July 2021 (see Appendix B).

The instrument used to collect student test responses for the smaller sample was Google Forms. The end of course assessment was an electronic form the researcher created to represent the content of the entire nine-week class. Students were asked to complete the 20-question assessment at three different points during the quarter they were enrolled in Introduction to Computer Science: the beginning, middle and end of the nine-week quarter. Only the end of quarter assessment data was used. A copy of form is provided in Appendix C. The content covered by this assessment is given in multiple-choice form, with pictures to assist when appropriate. Since the coding platform used is block-based, pictures were required to help

students identify which piece of code was being utilized. Though the test was given three times, only end of quarter assessments will be used.

An electronic form was used to easily distribute the instrument to students and tabulate results easily. The school district Middle School A resides in uses Google Classroom as its digital learning platform. Since Google Forms is integrated into the Google Suite and students have used it before, it was chosen to simplify the process for both students and researcher.

Data Collection Procedures

All students completed the test in the computer science classroom, with the instructor/researcher present between January of 2018 and June of 2021. Tests were distributed digitally using Google Forms. The questions were automatically randomized to prevent cheating between students. The program locked all other computer tabs from being opened so students could not refer to the internet or notes from the course. Students all took the test in a quiet environment and could take up to 30 minutes to complete the 20-question test.

Student emails were collected when the tests were completed only to relate the corresponding pre-, mid- and post-tests with the same subject; they were removed from the final evaluation. No demographic questions were included. All associated materials posted in the room were covered prior to students taking the test. Students were only able to take the test at school with instructor/researcher present.

The information was stored on the researcher’s Google Drive, only accessible to her and the Director of College and Career Readiness, whom the data was shared with. The link to the test itself could only be accessed through Google Classroom, which students must enroll into the be able to view content and is monitored closely by the researcher. The tests are locked so that they may only be taken once each on a student’s Google account.

To collect grade point average data, a report was run through the district's information management system, Infinite Campus. This allowed GPA data to be collected for every student in the school for each quarter from 2017-2021. All names and identifying information were removed from this data to protect students' privacy.

Data Analysis

Correlational studies determine whether a statistical relationship exists between the independent and dependent variable (Mertler, 2019). This correlational study looked to see if there is a relationship between length of class in minutes per period and student learning. In this study, the independent variable is the schedule students were exposed to and will be evaluated with both dependent variables – GPA for the overall school and end of course assessment scores.

Two one-way ANOVA tests will be applied to each data set: GPA and end of quarter assessment scores for each year from 2018 to 2021. This will be used to determine if schedule change provided a significant impact on student learning. Any score with a p value that is less than 0.05 is considered significant in one-way ANOVA tests (Mertler, 2019). This will determine whether the schedule change had a positive, negative or no effect on both GPA and end of course assessments.

Limitations

End of course data from the first semester of 2017-2018 was not taken, but the following semester was, meaning that the first year of data is smaller than the others. Additionally, because of COVID-19, data for the second semester of the 2019-2020 school year will not be used; it was not collected in the same way the other tests were and the students receiving virtual instruction did not receive instruction on the same learning targets as those who were taught in-person. Finally, because of COVID-19 and virtual learning, the Middle School A did not use traditional

letter grading for the middle school. Instead, they opted to use a Pass/No Pass system for quarter four of 2020. This made data for that quarter unavailable.

While no demographic data was taken, relating this study to other schools, especially diverse or urban schools will be difficult. The suburban school district Middle School A is in has limited racial diversity, so other demographics may see different results.

Summary

The purpose of this research was to explore whether there is a relationship between class schedule and student skill mastery. While there has been a lot of research into whether block scheduling is effective in the late 1990s and early 2000s, little research has been done since. Yet, schools still use block scheduling in a large proportion.

Grade point average for all students and an end of quarter assessment data for Computer Science students was collected since the 2017-2018 school year. In the 2017-2018 school year, the school had a seven-period, 56-minute class schedule. For both the 2018-2019 and 2019-2020 school year, the schedule was an eight-period with 46-minute classes. The 2020-2021 school year brought an alternating A/B schedule that consisted of four periods a day at 96 minutes each. Both GPA and end of course data will be compared from each of these schedules to see if a significant change in student learning occurred using an ANOVA test. Chapter IV presents the analysis of the data.

Chapter IV: Results

The purpose of this study was to determine if there was a relationship between class length and student achievement. Specifically, it focused on the effect of three different schedules used in Middle School A, a suburban school district in southern Wisconsin between 2018 and 2021. Two pieces of ex post facto data was used: Grade point average and end of course assessment results for the Introduction to Computer Science course. All data collected had identifiers removed so subjects were anonymous. The specific research questions this study aimed to address were:

1. What effect does the number of instructional minutes have on student performance?
2. Did meeting daily versus alternate days affect retention of information as indicated by student performance?
3. Which schedule had the strongest student performance?

Demographics

Middle School A is the only middle school in the district, serving seventh and eighth students in southern Wisconsin with a total population ranging between 750 and 800 students each year. GPA data was collected from all students between the years of 2018 and 2021.

Introduction to Computer Science is a quarter-long exploratory course. The class is intended to be taken in seventh grade, though there are exceptions for students receiving interventions or additional classroom support. Students who did not complete the course as seventh graders can elect to take it in eighth grade. The subset of students in Introduction to Computer Science each year is about one-third of the total school population (see Table 1). A 20-question end of course assessment was given to all Introduction to Computer Science (ICS) students between the years of 2018 and 2021 (see Appendix C).

Table 1

Student Population by Year and Course

Year	Middle school student population	ICS student population
2018	761	124
2019	774	225
2020	787	225
2021	798	238
Total	3120	812

Three different schedules were used in this period: a seven-period traditional schedule with 56-minute classes in 2018, an eight-period traditional schedule with 46-minute classes in 2019 and 2020, and an alternating day block schedule with 96-minute classes in 2021 (see Table 2).

Table 2

Class Schedule Type and Details by Year

Year	Class length (mins)	Total minutes	Schedule type	Variables
2018	56	2,520	7-Period	Low EOC numbers
2019	46	2,070	8-Period	Not Applicable
2020	46	2,070	8-Period	COVID-19 Start, Remote 4th Quarter
2021	96	2,112	Block	COVID-19, Alternating Days

Grade Point Average Results

To determine whether the change in schedule affected students' achievement, two different one-way analysis of variance tests (ANOVA) were conducted on each GPA and end of quarter assessment score for the four years of data.

Grade point average was determined on the four-point scale, where an A is worth four points, a B three points, a C two points, and a D one point. In 2018, a seven-period, 56-minute traditional schedule was used at Middle School A. The GPA was highest of the four years tested at 3.31 in 2018 (see Table 3). The schedule transitioned to an eight-period block with 46-minute

classes in 2019 and that same schedule was also used in 2020. The grade point average dropped in 2019 to 3.18 and again in 2020 to 3.11. Because of COVID-19, Middle School A was remote for the final quarter of the school year in 2020. The entire suburban school district returned to face-to-face learning at the beginning of the 2021 school year. Additionally, to help reduce the amount of student travel and transition better to the high school, a four-period, 96-minute alternating block schedule was implemented this year. With the block schedule in place, the GPA rebounded slightly back to 3.18 (see Table 3).

Table 3

Grade Point Average by Year

Year	*N*	*M*	*SD*
2018	761	3.3082	0.68195
2019	774	3.1780	0.76236
2020	787	3.1116	0.79540
2021	798	3.1784	0.80322
Total	3120	3.1931	0.76594

The results of the ANOVA indicate that the effect of schedule was significant on GPA. When compared to the traditional seven-period day used in 2018, all *p* values were 0.05 or below: $p = 0.05$ in 2019, $p = 0.00$ in 2020, and $p = 0.05$ in 2021. A *p* value of 0.05 or less is considered significant (see Table 4).

Table 4

Grade Point Average Comparison of Means

Year	Comparison year	Mean difference	*p*	95% CI
2018	2019	0.13013*	0.005	[0.0273, 0.2330]
	2020	0.19653*	0.000	[0.0941, 0.2989]
	2021	0.12975*	0.005	[0.0277, 0.2381]
2019	2018	-0.13013*	0.005	[-0.2330, -0.0273]
	2020	0.06641	0.514	[-0.0356, 0.1684]
	2021	-0.00037	1.000	[-0.1020, 0.1013]
2020	2018	-0.19653*	0.000	[-0.2989, -0.0941]
	2019	-0.06641	0.514	[-0.1684, 0.356]
	2021	-0.06687	0.490	[-0.1680, 0.1013]
2021	2018	-0.12975*	0.005	[-0.2318, -0.0277]
	2019	0.00037	1.000	[-0.1013, 0.1020]
	2020	0.06678	0.490	[-0.0344, 0.1680]

Note. Means with an asterisk are statistically significant, $p < .05$.

End of Course Assessment Results

A One-Way ANOVA test was also used on the end of quarter assessment score for the Introduction to Computer Science course. These end of quarter assessments were 20 questions and results were displayed in percentages. Like the GPA results, the average scores of these end of quarter assessments fell each year since 2018. When the seven-period, 56-minute schedule was used in 2018, the average score on the end of course assessment was 82.14%, though the population used was smaller than the others. In 2019, when the eight-period, 46-minute traditional schedule was implemented, the mean score on the assessment was 81.36%. In 2020, the average test score dropped to 76.96%, despite having the same schedule as 2019. Finally, when the block schedule was implemented in 2021, the average end of course assessment result was 74.72% (see Table 5).

Table 5

End of Quarter Assessment Score by Year

Year	*N*	*M*	*SD*
2018	124	82.1371	13.42206
2019	225	81.3556	12.86287
2020	225	76.9556	14.05340
2021	238	74.6218	12.64010
Total	812	78.2820	13.54894

When tested using a one-way ANOVA, the scores were compared to the results of 2018, where the traditional seven-period schedule was used. The mean score dropped by only 0.78% between 2018 and 2019 when transitioning from seven-period to eight-period; the *p* value was 1.00, which is not significant. Between 2018 and 2020, the mean dropped 5.18% with a *p* value of 0.03, which was significant. Comparing 2018 and 2021, the mean fell 7.52% with a *p* value of 0.00, which is also significant (see Table 6).

Table 6

End of Quarter Assessment Comparison of Means

Year	Comparison year	Mean difference	*p*	95% CI
2018	2019	0.78154	1.000	[-3.1305, 4.6936]
	2020	5.18154*	0.003	[1.2695, 9.0936]
	2021	7.51525*	0.000	[3.6414, 11.3891]
2019	2018	-0.78154	1.000	[-4.6936, 3.1305]
	2020	4.40000*	0.003	[1.1023, 7.6977]
	2021	6.73371*	0.000	[3.4813, 9.9861]
2020	2018	-5.18154*	0.003	[-9.0936, 1.2695]
	2019	-4.40000*	0.003	[-7.6977, -1.1023]
	2021	2.33371	0.349	[-0.9187, 5.5861]
2021	2018	-7.51525*	0.000	[-11.3891, 3.6414]
	2019	-6.73371*	0.000	[-9.9861, -3.4813]
	2020	-2.33371	0.349	[-5.5861, 0.9187]

Note. Means with an asterisk are statistically significant, $p < .05$.

Summary

When comparing the means of both GPA and end of term assessment, scores have dropped over time. The highest recorded grade point average was in 2018 with 3.3082, when the traditional seven-period schedule was used. This was consistent with the highest end of quarter score average, with an 82%. This could have been impacted by having a smaller sample size than the other groups, but the downwards trend is evident and parallels those in GPA.

Chapter V: Discussion, Conclusion, and Recommendations

The purpose of this study was to determine if there was a relationship between class length and student achievement. Specifically, it focused on the effect of three different schedules used in Middle School A, a suburban school district in southern Wisconsin between 2018 and 2021. Middle School A used a traditional schedule for classes in 2018 through 2020, though there was a transition from seven-periods to eight-periods per day between 2018 and 2019. In 2021, a 96-minute alternating block schedule was implemented.

When starting this research, three questions were posed:

1. What effect does the number of instructional minutes have on student performance?
2. Did meeting daily versus alternate days affect retention of information as indicated by student performance?
3. Which schedule had the strongest student performance?

After data was collected, two separate one-way ANOVA tests were performed on data collected between 2018 and 2021. End of year grade point averages were collected from all students as well as end of quarter assessment scores from students enrolled in Introduction to Computer Science. Both data sets were compared to determine if the results showed significance, while means were compared by the year to view the overall trend of scores.

Discussion

To answer the first research question, “What affect did instructional minutes have on student performance?” both grade point average and end of quarter assessment data was compared using a one-way ANOVA test. The highest average GPA, 3.31, occurred in 2018 with the seven-period traditional schedule, when the amount of class minutes was the largest per quarter at 2,520. This also correlates with the highest average end of quarter assessment score in

Intro to Computer Science with an 82.14%. In 2019, when the schedule transitioned to an eight-period traditional, the total number of minutes dropped to 2,070 per quarter. This loss of time paralleled the dip in GPA, which fell by 0.13 to 3.18. However, the end of quarter assessment score average did not decrease nearly as much; the average score was an 81.36%, which is only a loss of 0.78%. Seeing that about seven and a half hours of instructional time were lost, the drop was minor.

To answer the final research question, it is difficult to draw conclusions. Based off numbers alone, the strongest end of quarter assessment score and highest GPA occurred in 2018, with the seven-period traditional schedule. However, the sample size was the smallest for end of course assessment data. While the grade point average fell by 0.13 in 2019, the end of course assessment score dropped by less than a percentage point, despite the sample size being much larger than 2018.

The largest change occurred between 2019 and 2020 end of quarter assessments, despite keeping the same eight-period schedule for both years. Average GPA only dropped by 0.07 to 3.11 but the end of quarter assessment for Intro to Computer Science fell to a 76.96%, a 4.4% decrease. This massive drop in end of quarter assessment scores is likely attributed to a massive world event that disrupted students' lives: COVID-19. Students did not attend in-person school after March 13, 2020 until September 1, 2020.

This change in environment was detrimental to not only students in suburban Wisconsin, but those around the world as well. Feng et al. (2021) preformed a study on Chinese primary school and middle-level grade 9 students to see the effects of COVID-19 remote learning on end of year assessment scores. When looking at the scores for students, they found that scores dropped significantly between the semesters where students attended in-person and remotely.

Despite the need for remote learning for this time, student learning was not as effective as in-person across the board, especially in the subjects of math and Chinese (Feng et al., 2021). Students' scores were lower in nearly all subjects, regardless of student age or gender. The pandemic caused students to struggle, which accounts for a drop in test scores.

Despite the focus of this research being on schedule and its effects on student learning, the two years where the schedule was the same, 2019 and 2020, had the largest change in end of course results between adjacent years. In theory, these two years should be similar since no other changes occurred, but that was not the case.

When block scheduling was proposed at Middle School A, the choice was made for two reasons: to reduce the number of classes students went to in a day to potentially slow the spread of COVID-19, and to help align the middle school schedule with the one used at the high school. This implementation came during the transition to in-person school when student stress was high, mask-wearing was mandatory and two-week quarantines loomed over nearly everything.

The second research question posed was "did meeting daily versus alternate days affect retention of information as indicated by student performance?" When block scheduling was proposed at Middle School A, the choice was made for two reasons: to reduce the number of classes students went to in a day to potentially slow the spread of COVID-19, and to help align the middle school schedule with the one used at the high school. This implementation came during the transition to in-person school when student stress was high, mask-wearing was mandatory and two-week quarantines loomed over nearly everything.

When students returned to school in 2021, Middle School A implemented an alternating day 96-minute block schedule. The grade point average rebounded slightly from 3.11 to 3.18. However, the end of quarter assessment average fell from 76.96% to 74.62%, a decrease of

2.34%. This could be because students went from having Computer Science daily to every other day. Alternating day schedules can be difficult for students to adjust to because of the loss of continuity, especially for those with ADHD and those with learning disabilities (Santos & Rettig, 2003).

If looking only the non-COVID eight-period schedule year, 2018, and alternating block year, the results are similar; the grade point average for both was years 3.18. This is consistent with what Lewis et al. (2015) found when comparing block scheduling to traditional: students performed as well or better than those using traditional schedule. However, the end of quarter assessment score for Introduction to Computer Science averages dropped by 6.7%, from an 81.4% to a 74.6%. This could be because students often struggle with continuity in alternating days, especially students with learning disabilities and because block scheduling can be difficult for students to make up work for absences (Santos & Rettig, 2003). The two pieces of data from this study conflict, which makes it difficult to draw conclusions. Further data should be collected to see the impact of this change.

Conclusions

When this study started, the goal was to see whether class schedule had an impact on student learning for both instructional minutes and schedule type. However, COVID-19 makes drawing conclusions difficult. Students were facing increased stress, absences due to illness or quarantine and remote learning.

Prior to 2020, scores dropped between the seven-period and eight-period schedule change from 2018 to 2019, but this could be because of the loss in minutes or in the larger sample size. Additionally, the change in average test score was very small while GPA was much larger. The two years that had the same schedules, 2019 and 2020, saw the largest drop in end of quarter

assessment but GPA was not significant. On returning to school in 2021, the GPA scores increased slightly compared to the previous year, but the test scores did not show the same recovery.

Nonetheless, the trend of the end of quarter test scores is downward, though pin-pointing the reason on amount of time in class, schedule or alternating days is impossible. Grade point average saw similar results, but the trends were not parallel.

Recommendations

Further research is needed to determine the effect of class schedule on student learning. Only one year of data was gathered after the block schedule was implemented, so additional years of data would help compare. Unfortunately, the inclusion of the 2019-2020 school year seems to illustrate the effect of COVID-19 on learning instead of class schedule.

As Middle School A continues with block scheduling, bringing in other courses and even additional departments into the study would give a more wholistic view of how the change has affected student learning. Adding other measures, like progress monitoring math and ELA tests, could provide further insight. Since students transition to High School B where block schedule has been used for several years, GPA data could be expanded to include their results as well. This could also provide insight in the future to see if having block scheduling at Middle School A helped students transition to the high school.

Other studies of block scheduling included qualitative data from staff and students with their thoughts and opinions of the schedule change. An interesting avenue would be to interview students who moved on to the high school to see what perceptions they have of the impact of the schedule change as they transitioned to a 96-minute.

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Appendix A

High School A Block Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
1 7:30 - 8:40	Period 1 Yellow	Period 2 Red	Period 1 Yellow	Period 2 Red	Period 1 Yellow
2 8:45 - 9:55	Period 3 Blue	Period 4 Pink	Period 3 Blue	Period 3 Blue	Period 2 Red
Flex 10:00 - 10:30			Advisory 10:00 - 10:45		
3 10:35-12:15	Period 5 Orange	Period 5 Orange	Period 4 Pink (10:50-12:30)	Period 5 Orange	Period 4 Pink
4 12:20 - 1:30	Period 7 Purple	Period 6 Green	Period 7 Purple (12:35-1:45)	Period 6 Green	Period 6 Green
5 1:35 - 2:45	Period 8 Silver	Period 8 Silver	Early Release	Period 8 Silver	Period 7 Purple

	M, T, Th, F	Wednesday
3 (A Lunch)	Lunch 10:35 - 11:00 Class 11:05 - 12:15	Lunch 10:50 - 11:15 Class 11:20 - 12:30
3 (B Lunch)	Class 10:35 - 11:10 Lunch 11:10 - 11:35 Class 11:40 - 12:15	Class 10:50 - 11:25 Lunch 11:25 - 11:50 Class 11:55 - 12:30
3 (C Lunch)	Class 10:35 - 11:45 Lunch 11:50 - 12:15	Class 10:50 - 12:00 Lunch 12:05 - 12:30

M-T-Th - Lunch is held during Block 3 - Period 5 - Orange

W/Fr - Lunch is held during Block 3 - Period 4 - Pink

Appendix B

IRB Approval Document

UNIVERSITY OF WISCONSIN
STOUT
WISCONSIN'S POLYTECHNIC UNIVERSITY

Office of Research and Sponsored Programs

101 Vocational Rehabilitation
University of Wisconsin-Stout
Menomonie, WI 54751-0790

Phone: 715.232.1126

July 13, 2021

Amanda Northard
Teaching, Learning, & Leadership
University of Wisconsin-Stout

RE: The impact of class schedule on student learning in a middle-level computer science classroom

Dear Amanda,

The IRB has determined your project, "*The impact of class schedule on student learning in a middle-level computer science classroom*" is **Exempt** from review by the Institutional Review Board for the Protection of Human Subjects. The project is exempt under **Category #4** of the Federal Exempt Guidelines. Your project is exempt for 5 years from **July 13th, 2021**. If a renewal is needed, it is to be submitted at least 10 working days prior to the approvals end date. Should you need to make modifications to your protocol, please complete the modification form.

Informed Consent: All UW-Stout faculty, staff, and students conducting human subjects' research under an approved "exempt" category are still ethically bound to follow the basic ethical principles of the Belmont Report: 1) respect for persons; 2) beneficence; and 3) justice. These three principles are best reflected in the practice of obtaining informed consent from participants.

If you are doing any research in which you are paying human subjects to participate, a specific payment procedure must be followed. Instructions and form for the payment procedure can be found at http://www.uwstout.edu/rs/paymentofhumanresearchsubjects.cfm

If you have questions, please contact the IRB office at 715.232.5260, or mensink@uwstout.edu, and your question will be directed to the appropriate person. I wish you well in completing your study.

Sincerely,

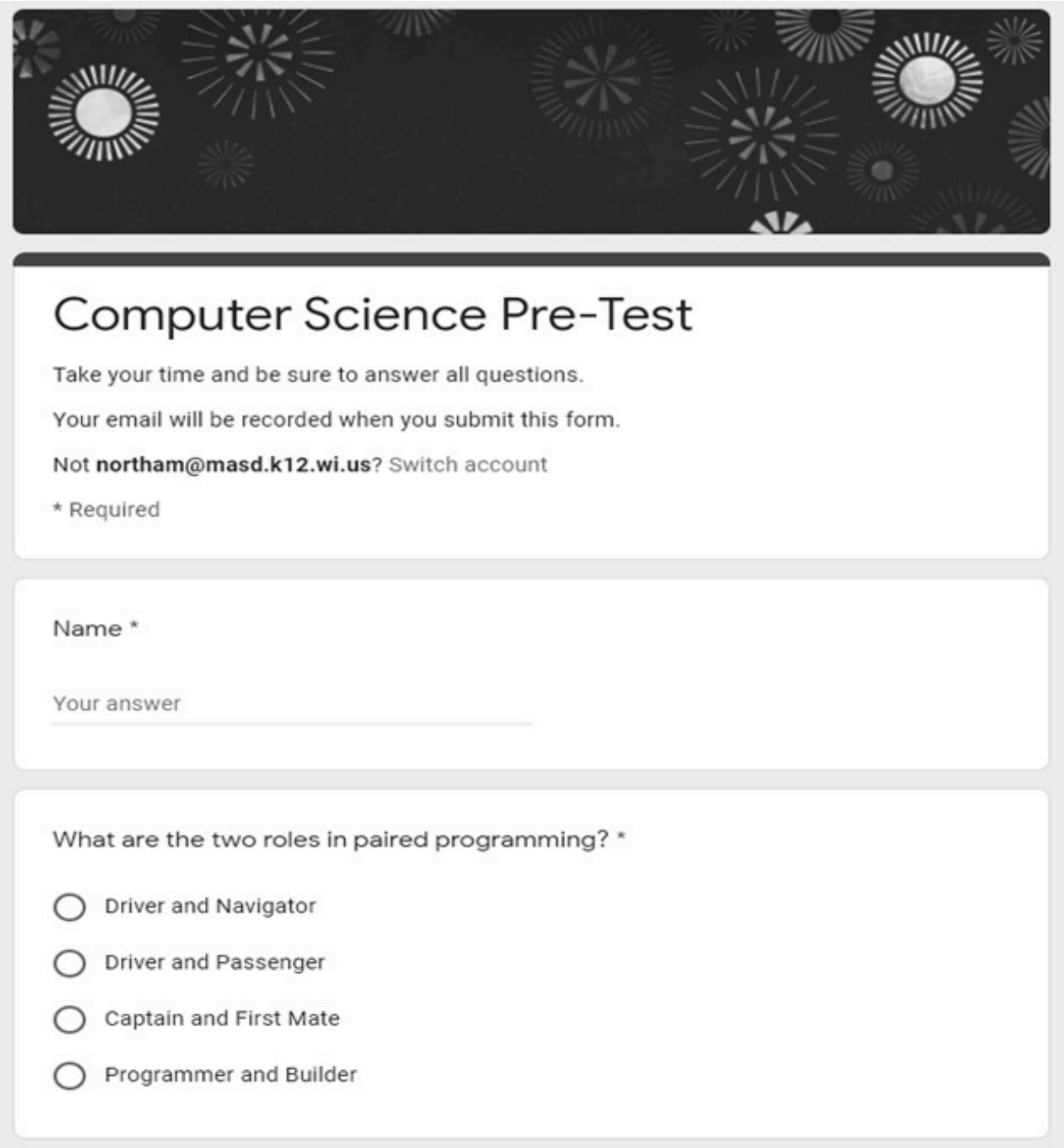
Mike Mensink
Interim Human Subjects Protections Administrator, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research

CC: Debbie Stanislawski

Appendix C

Test Instrument

The pre-, mid-, and post-tests are identical; question order is randomized for each student by Google Forms.



Computer Science Pre-Test

Take your time and be sure to answer all questions.

Your email will be recorded when you submit this form.

Not **northam@masd.k12.wi.us**? Switch account

* Required

Name *

Your answer

What are the two roles in paired programming? *

- ◯ Driver and Navigator
- ◯ Driver and Passenger
- ◯ Captain and First Mate
- ◯ Programmer and Builder

What two pins should never be connected because of safety reasons? *

- ◯ Pin 0 and Ground
- ◯ Pin 0 and 3V
- ◯ 3V and Ground
- ◯ Pin 0 and Pin 1

A pressure sensor is considered what? *

- ◯ Analog
- ◯ Digital

A flex sensor is what? *

- ◯ An input
- ◯ An output
- ◯ An external drive
- ◯ A peripheral

What does the radio command do? *

- ◯ Send a signal to other micro:bits
- ◯ Plays music through the speaker
- ◯ Picks up messages from radio waves
- ◯ Other

What two pins should never be connected because of safety reasons? *

- ◯ Pin 0 and Ground
- ◯ Pin 0 and 3V
- ◯ 3V and Ground
- ◯ Pin 0 and Pin 1

A pressure sensor is considered what? *

- ◯ Analog
- ◯ Digital

A flex sensor is what? *

- ◯ An input
- ◯ An output
- ◯ An external drive
- ◯ A peripheral

What does the radio command do? *

- ◯ Send a signal to other micro:bits
- ◯ Plays music through the speaker
- ◯ Picks up messages from radio waves
- ◯ Other

How far does a standard servo turn? *

- ○ 90 degrees
- ○ 270 degrees
- ○ 180 degrees
- ○ 360 degrees

Inputs get connected to a numbered pin and what else? *

- ○ 3V
- ○ GND

What pin does the speaker always have to be connected to? *

- ○ Pin 0
- ○ Pin 1
- ○ Pin 2
- ○ 3V

Outputs get connected to a numbered pin and what else? *

- ○ 3V
- ○ GND

What block turns an LED on? *

Analog Write Pin:0

Analog Write Pin:1023

Digital Write Pin:0

Digital Write Pin:1

What drawer is the clear screen block in? *

- Basic
- Basic - More
- Advanced
- Game

If the light sensor is reading the maximum value, it means the room is... *

- ◯ Very bright
- ◯ Very dark

What is the range of a digital sensor? *

- ◯ 0-255
- ◯ 0-1023
- ◯ 0 or 1
- ◯ 1-10

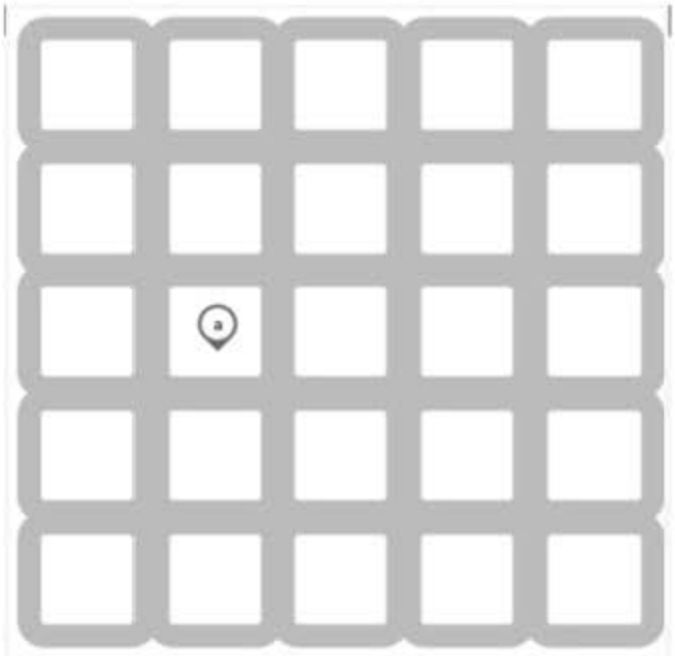
In a flowchart, what shape is used to show a decision is being made? *

- ◯ Oval
- ◯ Circle
- ◯ Rectangle
- ◯ Diamond

When a decision is being made in a code, it means that code will always have what in it? *

- ◯ If/Else Block
- ◯ Loop Block
- ◯ Analog Read Pin Block
- ◯ LED Block

What point is being represented by the grid? *



- ◯ (2,3)
- ◯ (3,2)
- ◯ (1,2)
- ◯ (2,1)

What block is used to scroll text? *

- ◯ Text
- ◯ Send Message
- ◯ Show String
- ◯ Many, you have to make each letter individually

Submit