

Data Analysis of 21st Century Community Learning Center

by

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Abstract

Students who come from low-income families tend to fall behind students who don't. To help these students catch up and succeed, 21st Century Community Learning Centers program was created. The program is designed to help students after school improve themselves academically. The program collects data about their assessment, attendance, and survey of the program. All of this data needs to be used to determine if the program is achieving its goal. In order to make use of the data it has to be cleaned and processed. The data for assessment and attendance show that program succeeding overall. Associated rule mining is used to find unique rules about the program based on participates feedback. The program is still in its early stages and needs work with the data collection process and working with data scientists can help improve this problem.

Index Terms—21st Century Community Learning Centers, 21CCLC, Associated rule mining, Assessment, Attendance, Survey

I. INTRODUCTION

During the pandemic the country issued a stay-at-home order where people were not allowed to leave their house unless absolutely necessary. This meant kids could no longer attend school in person and had to learn through online learning. Kids who attend schools that are low-income tend to already be behind academy compared to others. Combine the already existing problem with the shut-down from the pandemic those students fall even further behind.[6] This wasn't the only problem that affected these students the pandemic as affected many of there mental health as well.

This is where the 21st Century Community Learning Centers (21CCLC) program comes in. The program's purpose is to provide opportunities for communities to establish or expand activities in community learning centers that serve primarily students who attend eligible schools with a high concentration of students from low-income families. Its goal is to provide academic and enrichment opportunities, increase the social emotional skills and increase school attendance.

The social work department at Lewis University is working with the Valley View School District. The program is led by a Dr. Shayman and her small team of student social workers. The program currently serving over 700 students and 500 families. The team has collected three different sets of data from schools that are participating in the program. Data collected was for assessment, attendance and surveys, this raw data collection can be used to help determine if the program is achieving its goals.[1][2][3][4][5] Table I and II shows the description in terms of type and statistical feature for select features in each of the raw datasets collected. Using these select features to will give an understanding how well it program is achieving its goal. Tables III, IV, and V show the questions found in the surveys. Using these tables, the question code can be swapped with the question shorthand to make it easier to read.

Table I: Description of Assessment Dataset

Attribute	Type	Example Value	Description
Student ID	Numeric (Int)	132456	Unique numbers for a given student
Full Name	Nominal (String)	John Doe	Full name of student
FARMS	Nominal (String)	Free	Status of school lunch
LEP	Nominal (String)	Y	Students who have limited English proficiency
IEP Flag	Nominal (String)	Y	Students who are in individual education program
Aug Lexile	Numeric (Int)	500	Reading Score for August
Sep Lexile	Numeric (Int)	500	Reading Score for September
Dec Lexile	Numeric (Int)	500	Reading Score for December
Number Achieve Activities	Numeric (Int)	10	Number of activates student participated in Achieve program
Passing Achieve Activities	Numeric (Int)	8	Number of activates student has successfully passed in Achieve program

Table II: Description of Attendance Dataset

Attribute	Type	Example Value	Description
Full Name	Nominal (String)	John Doe	Full name of student
School	Nominal (String)	HHH	Abbreviation of School Name
Dates; Ex: (3/15/21)	Nominal (String)	P	Marks if a student is present or absent from after-school program for each school day

Table III: Teacher Survey Questions

Question Code	Full Question	Question Shorthand
Q11	Do you believe this student's parent(s)/guardian(s) are supportive of their participation in the program?	Parents Support
Q12	In your opinion, is the student's parent/guardian(s) actively involved with their education?	Parents Actively Involved
Q16_1	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Turning in their homework on time	Doing Homework on Time
Q16_2	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Completing homework to your satisfaction	Homework is satisfaction
Q16_3	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Participating in class	Participation
Q16_4	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Volunteering (e.g., for extra credit or more responsibilities)	Volunteering
Q16_5	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Attending class regularly	Attending Class
Q16_6	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Being attentive in class	Attentive in Class
Q16_9	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Coming to school motivated to learn	Motivated to Learn
Q16_10	In the last two months, to what extent has your student changed their behavior in terms of each of the following: - Getting along well with other students	Getting along

Table IV: Student Survey Questions

Question Code	Full Question	Question Shorthand
Q6	My teachers at the after-school program care about me.	Teacher cares
Q9	I feel comfortable asking my after-school teachers for help.	Asking for help
Q10	The activities I do at the after-school program help me learn.	Activities help learn
Q13	It is important for me to do well in the after-school program.	Important to do well
Q14	I behave well when I am at the after-school program.	Behave well
Q15	I enjoy going to the after-school program.	Enjoy the program
Q16	I feel included in the group when I am at the after-school program.	Feel included
Q18	I ALWAYS try my best when I am at the after-school program.	Always tries their best
Q23_1	While you're at the after-school program, do you... - Practice reading	Practice reading
Q23_2	While you're at the after-school program, do you... - Learn math	Learn math
Q23_3	While you're at the after-school program, do you... - Practice writing	Practice writing
Q23_4	While you're at the after-school program, do you... - Play sports and games	Play sports and games
Q23_5	While you're at the after-school program, do you... - Hang out with friends	Hang with friends
Q23_6	While you're at the after-school program, do you... - Learn about feelings and emotions	Learn about feelings and emotions

Table V: Parent Survey Questions

Question Code	Full Question	Question Shorthand
Q4	The after-school program is helping my child_1's grades improve.	Grades improve
Q5	The after-school program is helping my child_1's behavior improve during the school day.	Improve behavior
Q7	The after-school program provides constructive activities for my child(ren).	Provides constructive activities
Q8	My child_1 has positive relationships with the staff members at the after-school program.	Positive relationship with staff
Q10	I believe my child_1 enjoys the after-school program.	Enjoys the program
Q11	I consider myself to be involved in my child(ren)'s education.	Involved in students' education
Q12	I am satisfied with the after-school program.	Satisfied with program
Q32	My community has a good amount of resources available for my family to use.	Available resources for family
Q33	I believe my child_1 generally enjoys being in school.	Enjoys schools
Q34	I believe my child_1 uses resources when they are available to him/her.	Students uses resources

II. RELATED WORK

There have been a few studies trying to improve education using statistics and machine learning. The all try to make improvements by trying to find relationships or patterns from their data. We will be looking at a few studies and see how they were able to get useful information. Y. Fang and C. Zhang (2008) use association rules analysis to enhance the quality of graduate education. They use it to view the curricula of the graduate education and look at the support and confidence. They use interesting to help decrease useless rules.[7]

Dr. Kumar and A.Chadha (2012) use association rule mining on student assessment data. It talks about how higher education is being flooded with educational data. There goal is to improve the quality of managerial decisions to help deliver quality education. They also show how important data preprocessing to the accuracy of the predicted results.[8]

III. PROJECT DESCRIPTION

The project from the 21st Century Community Learning Centers is to take all the raw data, clean it and create a master dataset and use the data to help prove the goals of the program are meet. The data provided by 21CCLC has assessment data on the students, their attendance in the program and surveys taken by students, parents, and teachers. The goals and objectives described by 21st Century Community Learning Centers are:

1. Create a master dataset including all the data provided.

2. Determine if the students attending the program are the ones with most needs.
3. Attendance over time.
4. Determine how students, parents, and teachers view the program.

This will be done by using graphs to view the trends of attendance, students who benefit from extra needs, and using associated rule mining on the surveys to find out how they feel about the program.

IV. ETHICS

Ethics is a big part of this project as it contains very sensitive information. A big part of this project is to desensitize any sensitive data from the dataset. The data contains names of the students, student IDs, ethnicity, sex, and birthdays. All of this is very sensitive information that can end up being very harmful if it gets into the wrong hands. It is important how the data is handled when using it. Another important part is who has access to this data and to only use the data when needed.

V. METHODOLOGY

Association rule mining is used to find associations and relationships from datasets.[9] It shows the relationship how the variables are associated to each other. Association rule mining works well with survey type data as its suitable for non-numeric compared to most machine learning techniques. It has two parts an antecedent and a consequent, an antecedent is, and item found in the dataset and consequent is item found in combination with antecedent. To determine how significant the finds associated rule mining uses support, confidence, and lift to determine the importance. Support measures how frequent the relationship appears among the entire datasets.

$$support = P(X \cap Y) \quad (1)$$

Confidence measures the occurrence of items together in the dataset.

$$conf = P(Y|X) = \frac{supp(X \cap Y)}{supp(X)} \quad (2)$$

Lift is the ratio of the joint probability of two items over the product of their probabilities. [11]

$$lift = \frac{supp(X \cap Y)}{supp(X) \times supp(Y)} \quad (3)$$

Using these metrics to determine important rules in the dataset to gather how the program is progressing. The logarithmic regression is a regression used to model growth or decay accelerates rapidly at first and then slows over time. [10] The equation has a dependent variable, y, a independent variable, x, and the regression coefficients, a and b. The following equation shows how the variables relate to each other when it's all put together.

$$y = a * \log(x) + b \quad (4)$$

The linear regression is a linear approach for modeling a relationship between the dependent and independent variable. The equation is very similar to logarithmic just with out the log. The equation contains dependent variable, y, a independent variable, x, an y-intercept, b, and coefficient a. [12]

$$y = a * x + b \quad (5)$$

The raw data provided by 21CCLC has multiple attendance spreadsheets, assessments and surveys that need to be combined. A lot of the data is sensitive, and the students need to be desensitized. To create the master dataset, it begins with cleaning up the attendance excel spreadsheet. There was a total of ten different attendance one from each school from the program. The first thing that needed to be done was to unmerge the rows that were combine. There were multiple entries in a few of the rows that had combine rows. This data needs separate columns to enter these, such as multiple phone numbers and emails. Once this data has been input into the newly created columns the extra rows from the unmerging are deleted. Each attendance excel spreadsheet has multiple tabs for each month the school has started the program. The excel sheets are upload into python and each tab into separate dataframes using pandas. An empty dataframe is created to combine all the tabs from the excel spreadsheet into one. Each tab is merged into one using the full name as the key. When merged into one

dataframe the duplicate columns are combined into one column filling to get as much data as possible. Then a column is inserted with abbreviation of the school the student attends. This is done for each attendance excel spreadsheet and joined into one dataframe using the append function from pandas. The assessment excel spreadsheet was uploaded into python into a dataframe. Using pandas on the assessment and attendance information was obtain using value_count function, bar charts, line graph. Then logarithmic regression on the Lexile and Achieve Activities data to find the relationship between them. For the survey data each of the surveys where upload into Orange3. Orange3 contains software for associated rule mining, and the ability to filter the data. The columns where first filtered and then ran through the associated rule mining to find the relationship between all the questions.

VI. RESULTS AND DISCUSSION

A. Master Dataset Creation

When attempting to create the master dataset, we are into a few issues. The first issue is the assessment data with the student grades was unusable due to it having data from other schools not in the program. For ethical reasons we were not able to use the data at all and requested assessment data that we can actually use and are currently waiting for it. The assessment data containing LEP, IEP Flag, Lexile and achieve activities had missing data. The data only contains students from August to December missing the students who were added afterwards. This data needs to be updated in order to get an accurate idea of the student's needs. The next issue we run into is with the attendance data. The attendance data had a lot of important missing data in order to create the master dataset. The student IDs are missing which is a problem when it comes to a few students sharing the same name. Another problem is misspelled names and not knowing which name is correct or if it is an actual student. In order to resolve these issues, the help of a teacher from the respected school will need to provide the correct and missing information. The student survey data had missing or incorrectly spelled names also no student ID for any of the students. The reason for the missing or incorrectly spelled name is that they were collected by paper and the people putting the name in the software couldn't read the handwriting or there wasn't a name. In order to make the master dataset all the excel spreadsheets need common keys. In this case the common keys were names and student IDs, but since attendance and survey data had missing or incomplete data it couldn't be combine. Even though the master

dataset couldn't be created the data was still usable and the creation of the master dataset will have to be a future project.

B. Assessment data

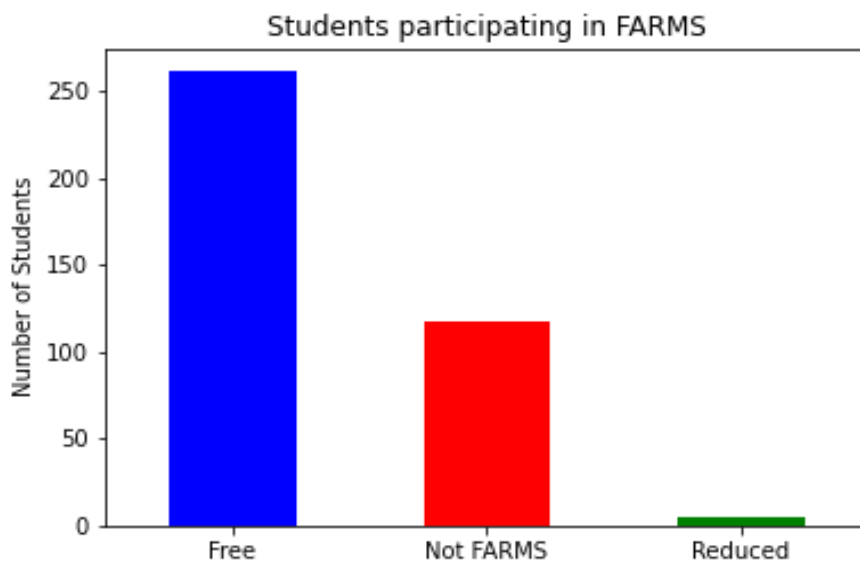


Fig. 1 Students who receive FARMS

The assessment dataset provided by 21CCLC gives information about students' needs. The FARMS data tells us if students get free or reduced lunch, and which don't. Looking at fig.1, it's a bar chart that shows the number of students who have benefited from FARMS. A total of 267 students out of 385 received free or reduced lunch, this helps to prove that the program is giving students who come from low-income families.

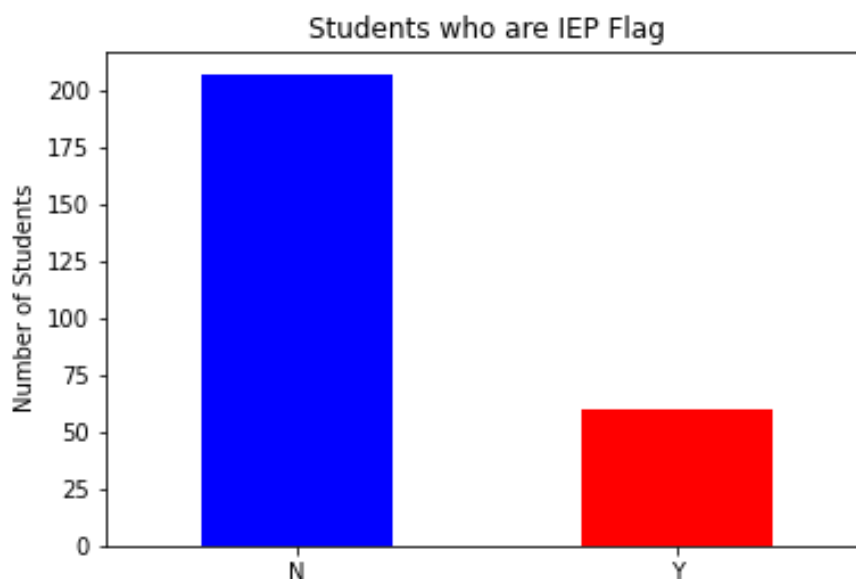


Fig. 2. Students who are IEP Flag

The program also checks to see if the students might need IEP Flag, fig. 2, shows this. IEP stands for individualized educational plan, which give students who have disability the help they need. It shows that 86 out of 267 students possibly need extra help. The data also shows how many students have a limited English by checking the LEP data. Fig. 3 shows 60 out of 267 students have limited English, so the program needs to make sure they have the resources for them. These three metrics supports that the program is helping students from low-come families and providing additional support for families.

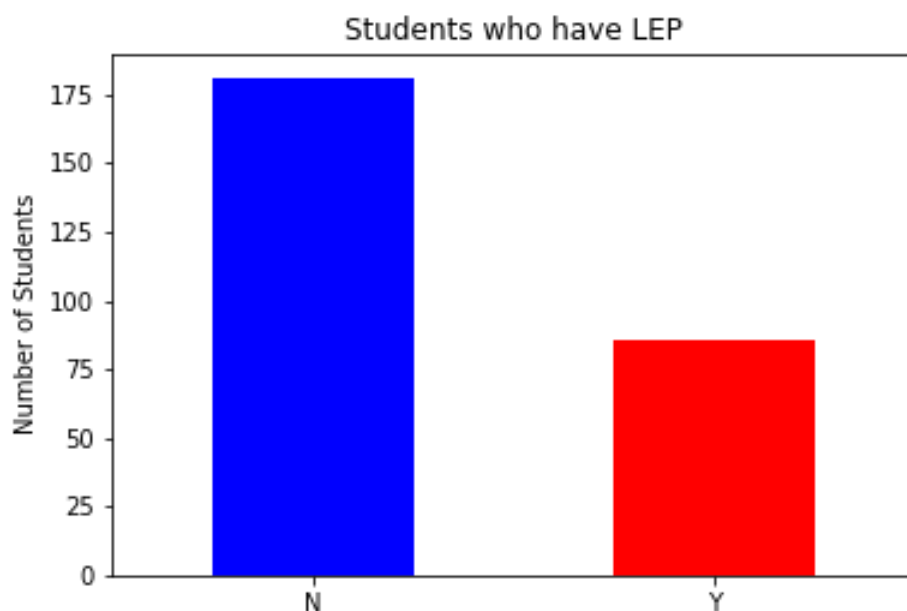


Fig. 3. Students who have LEP

The Lexile determines the reading level of the students. To determine if activities provide higher scores for Lexile a line graph is used comparing number of achieved activities and passing achieved activities. Looking at figs 4, 5, and 6, it shows that there is a slight upward trend the more activities a student participates in higher the score. A logarithmic and linear regression is used to determine the relationship between Lexile score and number of Achieve Activates. The number achieve activities data had a few zeros and for the logarithmic curve to work, one was added across the entire number achieve activities data.

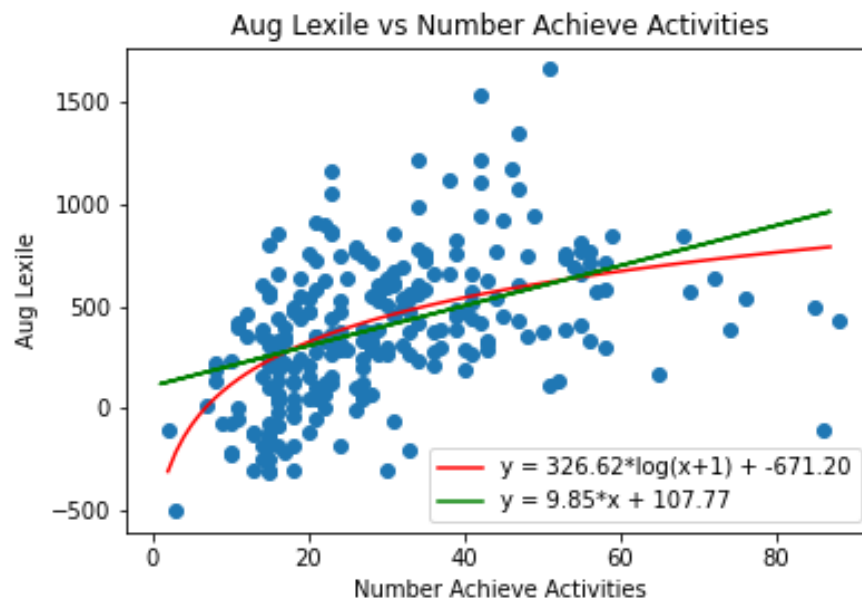


Fig. 4. Lexile score based on Number of Achieved Activates in August

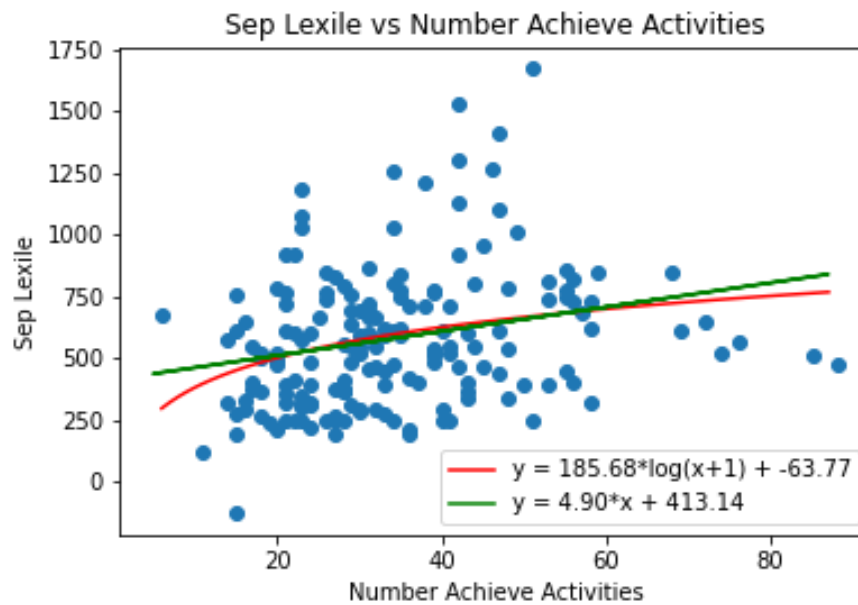


Fig. 5. Lexile score based on Number of Achieved Activates in September

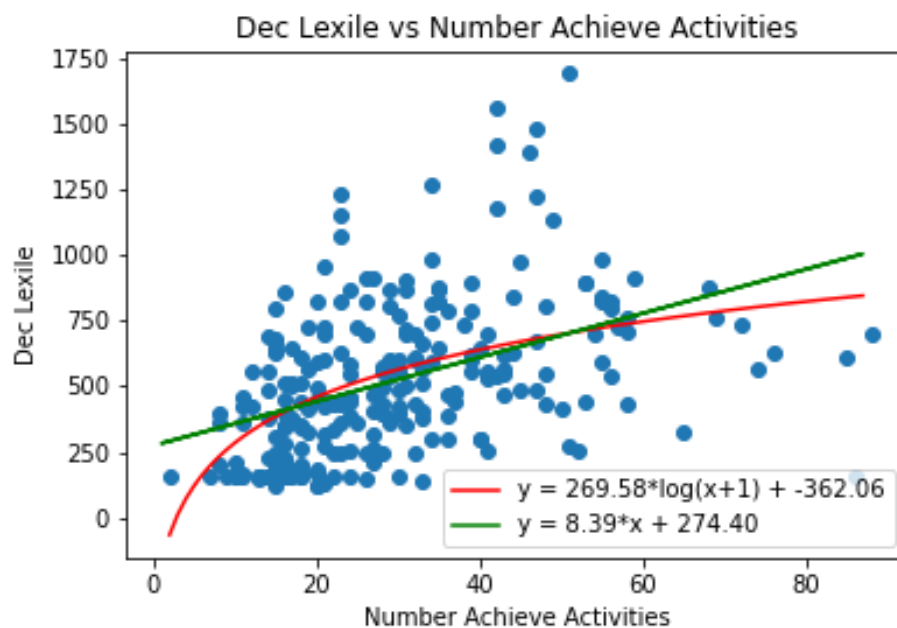


Fig. 6. Lexile score based on Number of Achieved Activates in December

Figs 7, 8, and 9 show that more activities a student is passing the better the Lexile score is. Indicating that passing achieved activities has more of an impact then participating in a lot of activities. This can be seen by comparing the logarithmic and linear equations. Comparing the log curve to the linear we can see that log curve fit the data much more then linear regression. The program needs to focus on helping students succeed in the Achieve activities to improve the reading levels of the students.

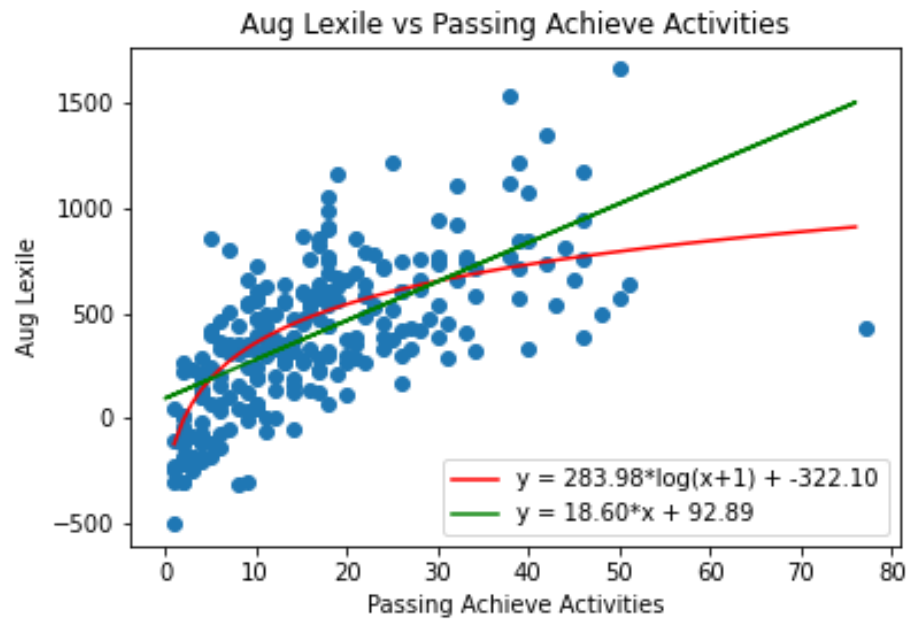


Fig. 7. Lexile score based on Passing of Achieved Activates in August

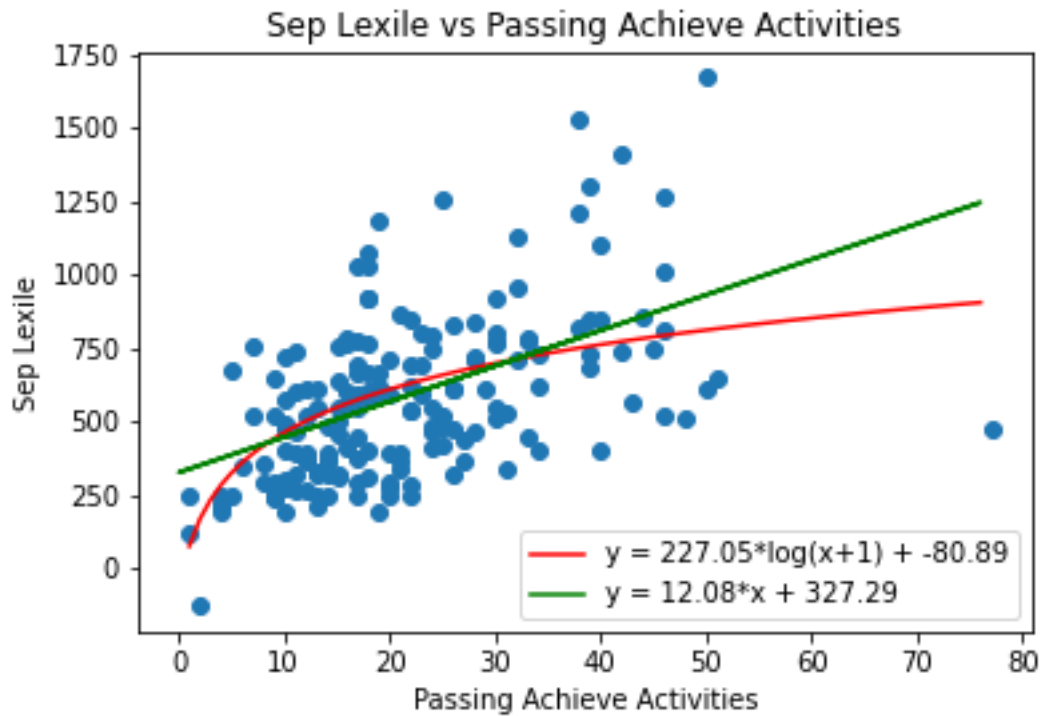


Fig. 8. Lexile score based on Passing of Achieved Activates in September

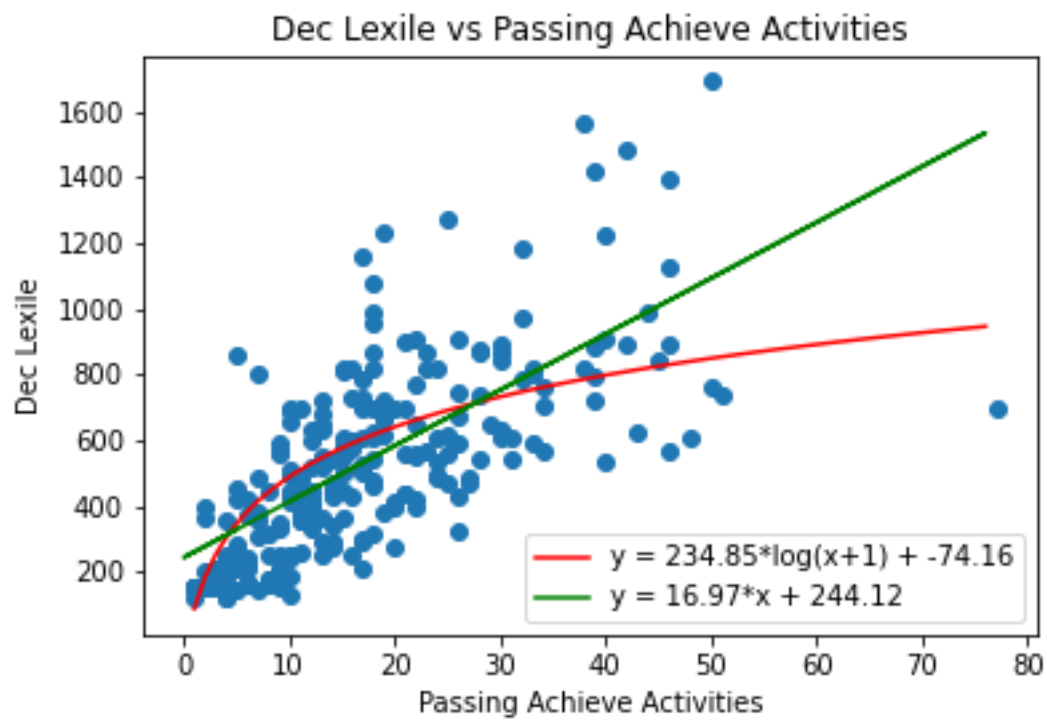


Fig. 9. Lexile score based on Passing of Achieved Activates in December

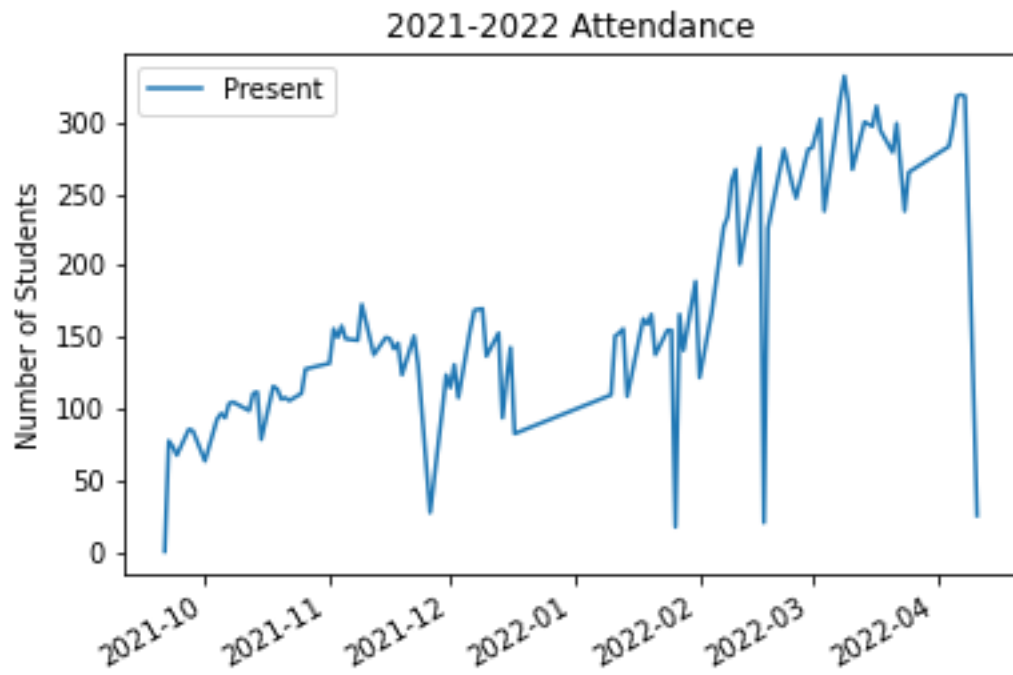
C. Attendance Dataset

Fig. 10. Attendance for all schools for 21CCLC program

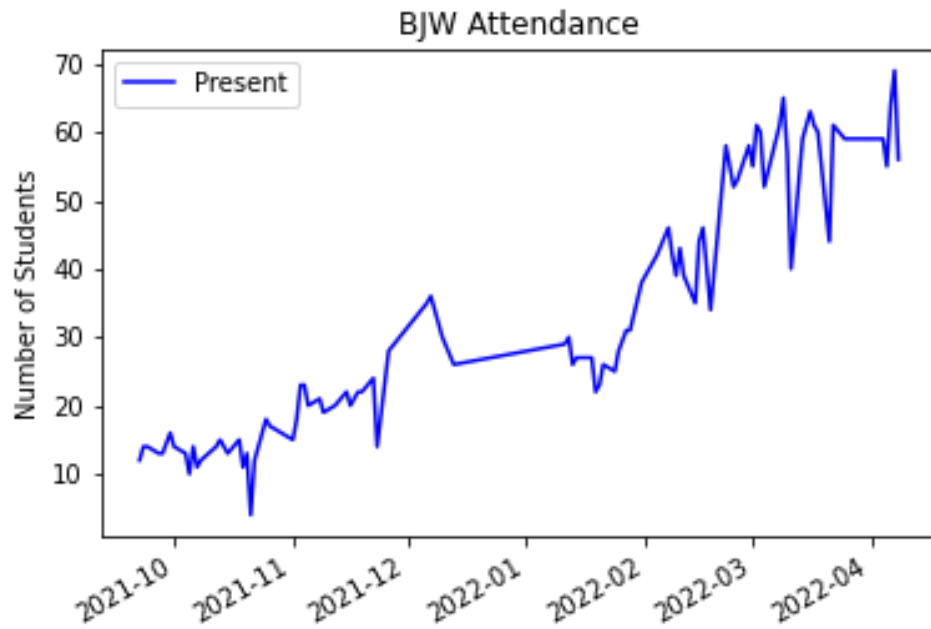


Fig. 11. Attendance for BJW student for 21CCLC program

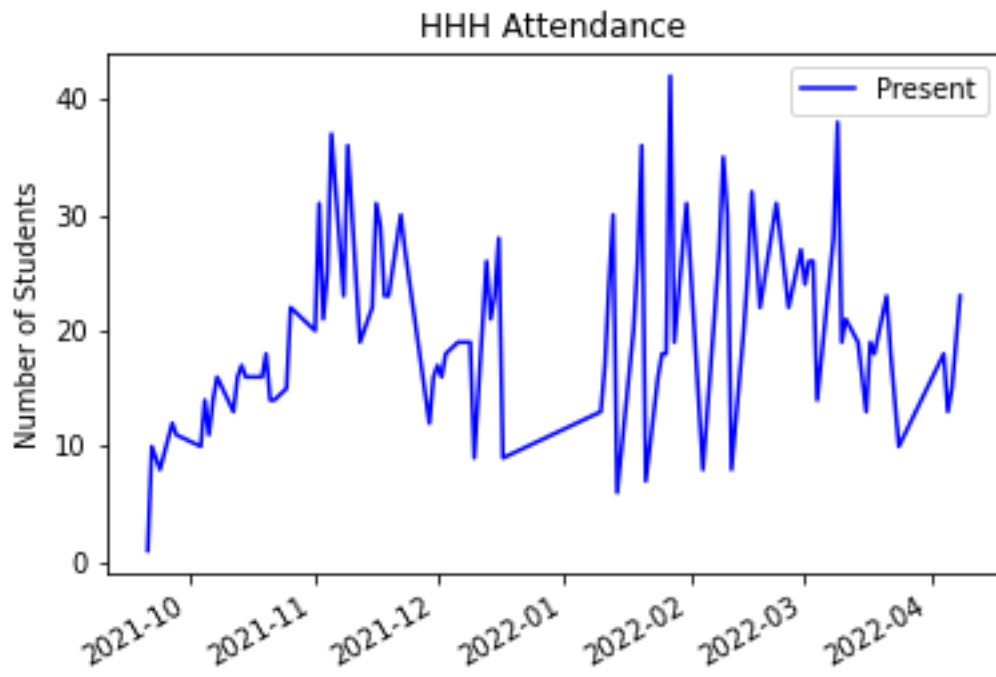


Fig. 12. Attendance for HHH student for 21CCLC program

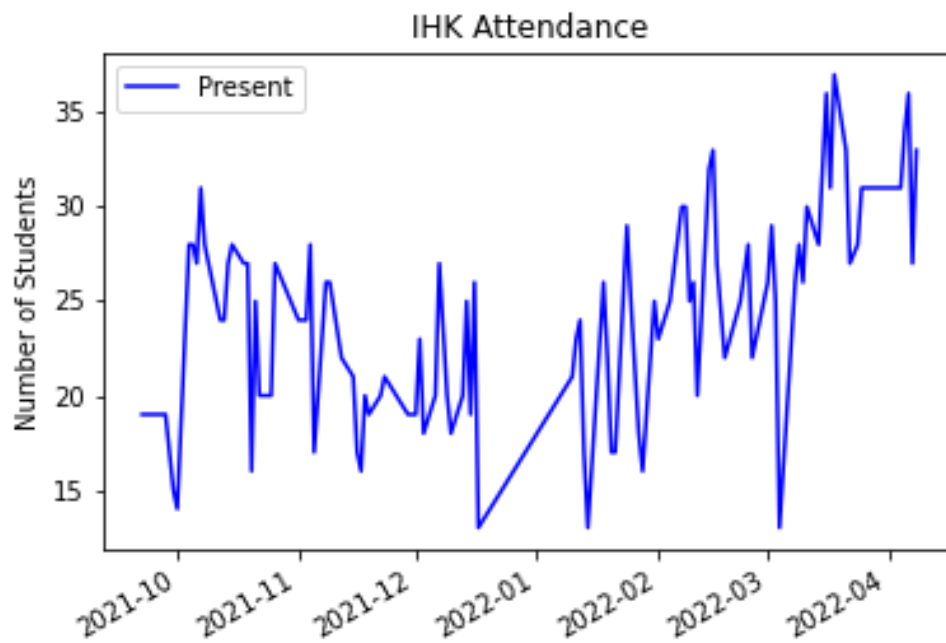


Fig. 13. Attendance for IHK student for 21CCLC program

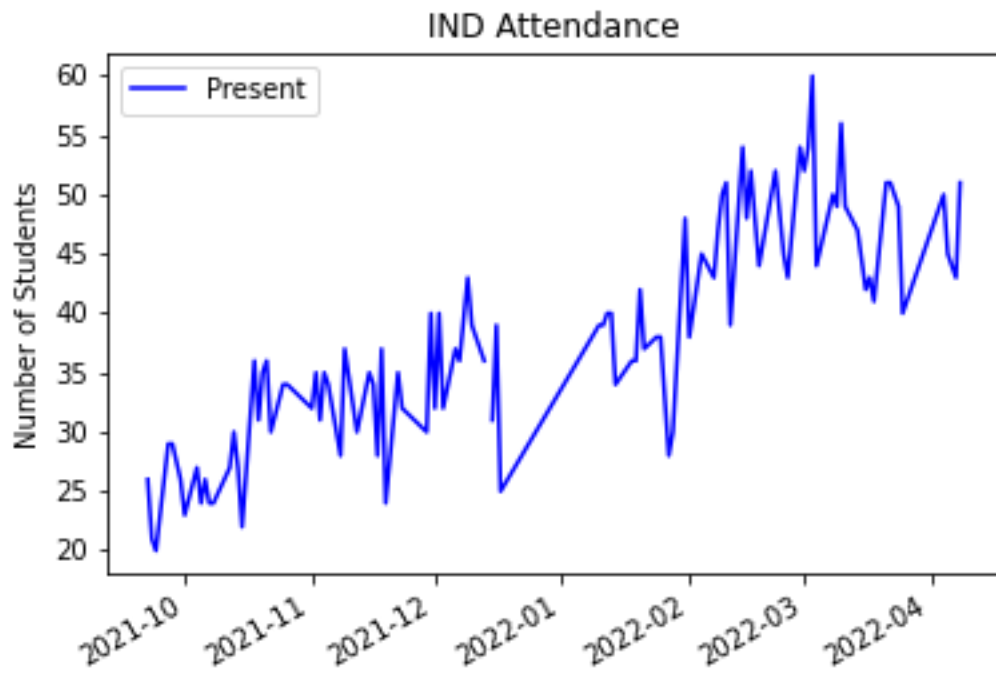


Fig. 14. Attendance for IND student for 21CCLC program

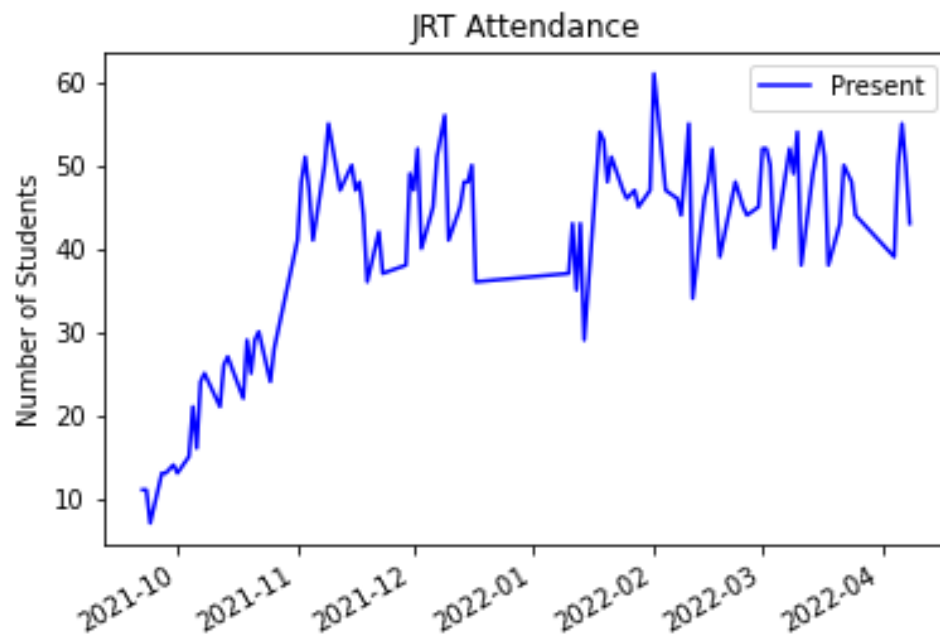


Fig. 15. Attendance for JRT student for 21CCLC program

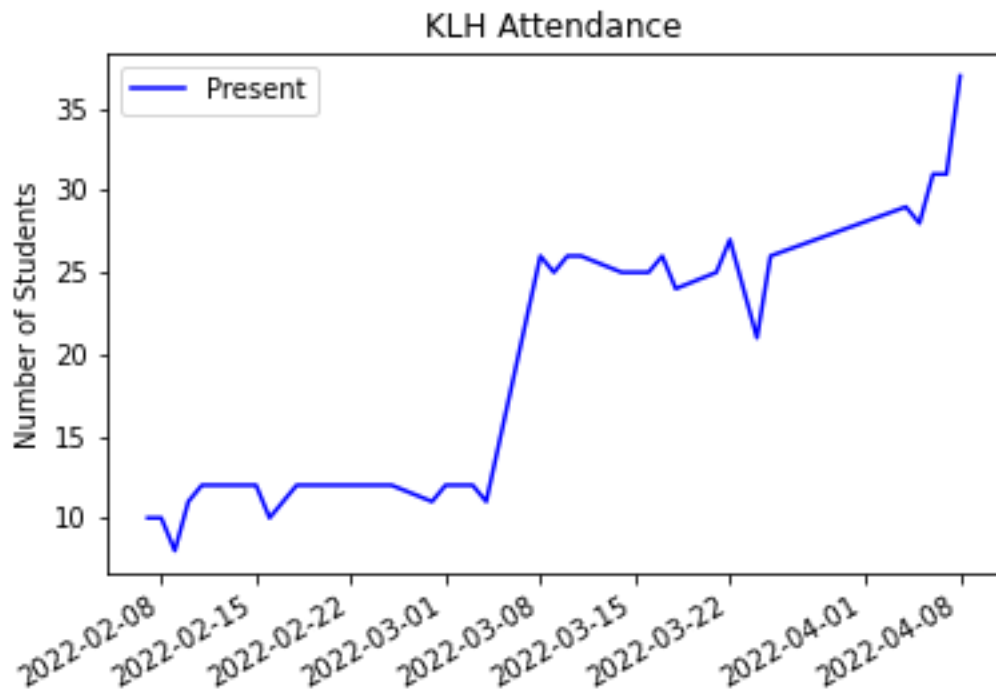


Fig. 16. Attendance for KLH student for 21CCLC program

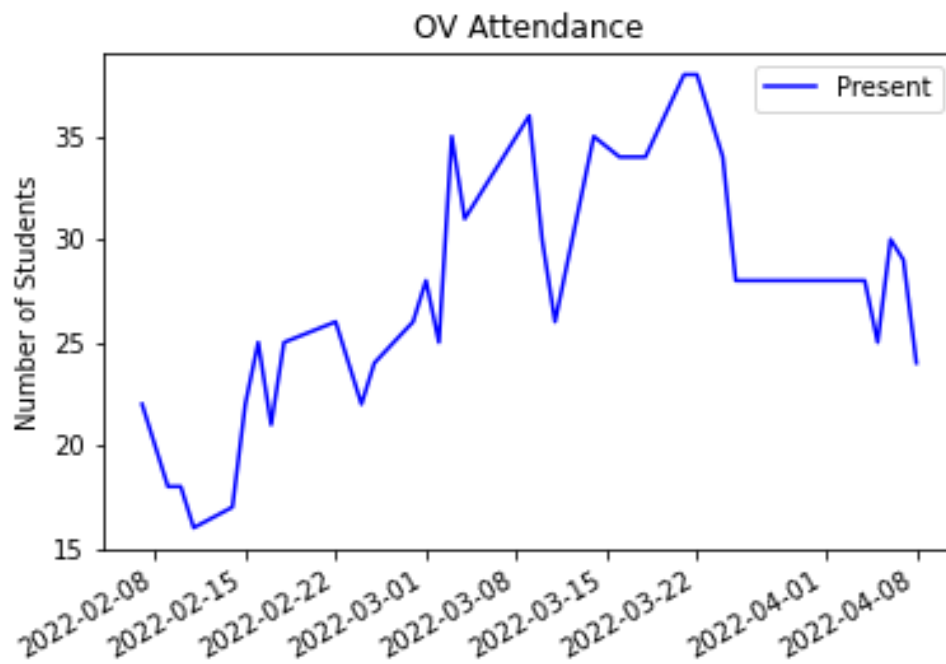


Fig. 17. Attendance for OV student for 21CCLC program

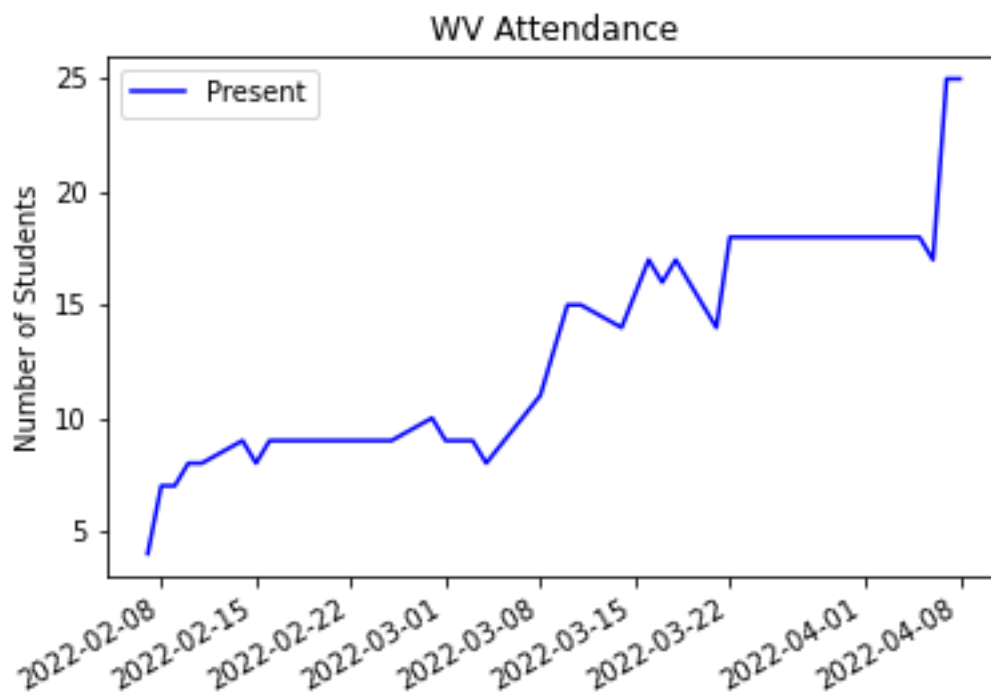


Fig. 18. Attendance for WV student for 21CCLC program

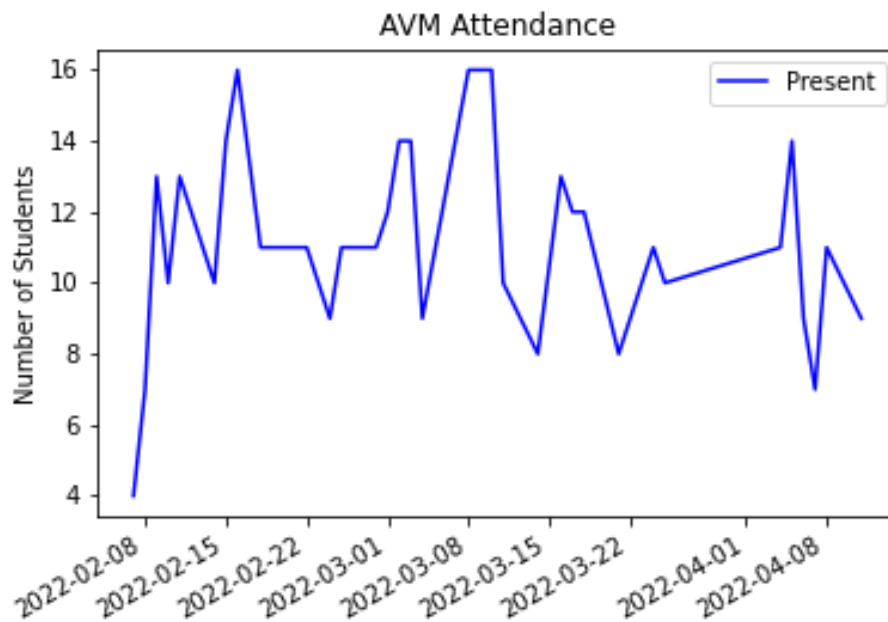


Fig. 19. Attendance for AVM student for 21CCLC program

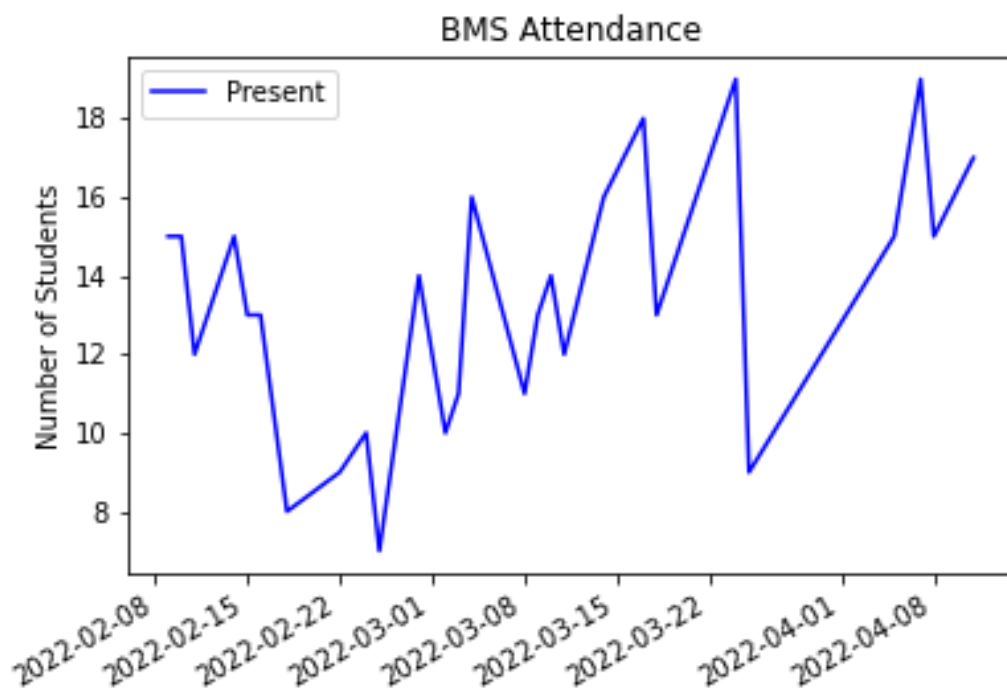


Fig. 20. Attendance for BMS student for 21CCLC program

Table VI: Average Attendance for the Program at each School

Schools	Average Attendance from the beginning of the School Year	Average Attendance after 2/8/2022
BJW	33	59
HHH	20	22
IHK	24	29
IND	38	48
JRT	41	47
KLH		28
OV		28
WV		13
AVM		12
BMS		14

The attendance dataset gives us insight on how many students attend the program. There is a total of 10 schools in this program. Looking at fig 10, it shows that more students attend as time goes on. One of the causes of this is due to more schools joining the program and another can be parents and students learning about the program from others. Right before the winter break and after attendance is down, shown in figs. 10, 11, 12, 13, 14, and 15 and that can be due to families trying to get back into routine. Also, a spike in attendance starting February is shown in fig. 10, when 5 more schools were added to the program. Looking at figs. 11, 14, 15, 16, and 18, the schools shown have a upward trend of attendance. The program at these schools are showing success in bringing students in. While looking at figs. 12, 13, 17, 19, and 20 they show that students show up in the beginning of the program but are not consistent as time passes. This is something the social workers have to look into and see what the program is offering. Investigate with the teachers to see what can be done to improve the student's needs. Table III shows the average attendance for each school. Looking at the first five schools at the average attendance from the beginning we can see that a good number of students attend this program. Then comparing those numbers to attendance after 2/8/2022 we can see the average is higher. This indicates that attendance has increased over time for those five schools. The attendance was low in the beginning but as time went on attendance increased showing that the program is helpful and meaningful to students.

D. Survey Dataset

Table VII: Associated Rule Mining on Teacher Surveys

Rule	Support	Confidence	Lift	Antecedent	Consequent
1	0.017	1	7.188	Volunteering =Significant Improvement, Attending Class =Significant Improvement, Motivated to Learn =Significant Improvement	Getting along =Significant Improvement
2	0.078	0.9	6.9	Parents Support =Yes, Parents Actively Involved =Yes, Attentive in Class =Significant Improvement, Participation =Significant Improvement	Motivated to Learn =Significant Improvement
3	0.035	1	8.846	Parents Support =Yes, Parents Actively Involved =Yes, Doing Homework on Time =No Change, Attending Class =Significant Improvement	Attentive in Class =Significant Improvement
4	0.061	1	8.846	Parents Support =Yes, Parents Actively Involved =Yes, Doing Homework on Time =Significant Improvement, Participation =Significant Improvement	Homework is satisfaction =Significant Improvement

The survey data gives insight on how everyone in the program feel about it. Using associated rule mining to find unique relationship. Starting with the teacher survey a few rules are found to see how different aspects of the program affect each other. These rules are chosen

by the lift value, the greater the lift value the more surprising the rule is. Looking at Table VII, there are four different rules found by associated rule mining. The first rule tells us that the teacher sees the students getting along when they are volunteering, attending class and are motivated to learn. For the program to succeed it helps when students get along making them want to come back. The second rule tells us when they have their parents are supportive and involved, they are attentive in class and participating, then they are motivated to learn. Parents play a huge role in their learning this is no secret, but the rule does reinforce that known notation. Rule three tells us that students are attentive in class when they have the support of their parents, parents are actively involved, and attending class. What's interesting about the rule is that doing homework has no effect on students being attentive in class. The last rule found from the teacher survey tell us homework is satisfaction when parents are supportive and involved along with homework is done on time and participation. These rules were all determine by their lift value and consequents that best determine how the program is doing.

Table VIII: Associated Rule Mining on Student Surveys

Rule	Support	Confidence	Lift	Antecedent	Consequent
1	0.011	1	1.706	Practice reading =No, Learn math =Yes, Practice writing =No, Play sports and games =Yes, Hang with friends= Yes, Learn about feelings and emotions =Yes, Asking for help =YES, always!, Important to do well =YES, always!, Behave well =YES, always!, Feel included =YES, always!, Enjoy the program =YES, always!	Activities help learn =YES, always!
2	0.408	0.91	1.309	Hang with friends =Yes, Teacher cares =YES, always!, Activities help learn =YES, always!, Always tries their best =YES, always!	Enjoy the program =YES, always!
3	0.672	0.929	1.197	Always tries their best =YES, always!	Teacher cares =YES, always!
4	0.402	0.921	1.406	Teacher cares =YES, always!, Asking for help =YES, always!, Important to do well =YES, always!	Feel included =YES, always!

The rules determine from the student surveys are shown on Table VIII. Four rules are found from the survey that show how the program is doing. The first rule shows a lot of variables that go lead to activities help learn. What's interesting from this rule is that practicing reading and writing doesn't matter in determining if activities help learn, while math does. This can be due to students in general have a harder time learning math versus reading and writing. The second rule is important one because it tells us what determining variables make the program enjoyable. We can see that spending time with friends, teachers caring, activities help learn and they try their best is what makes the program enjoyable for students. These variables are what helps the students to keep coming back to the program. The third rule shows us that if the students are

trying their best then the students see that their teachers care. This is a simple rule but important one because all it takes is for the students to try their best to see that the teachers care. The last rule tells us what leads to students feeling included in the program. Teachers caring, students asking for help and important to do well all leads to feeling included in the program.

Table IX: Associated Rule Mining on Parent Surveys

Rule	Support	Confidence	Lift	Antecedent	Consequent
1	0.419	1	1.396	Involved in students' education =Strongly agree, Satisfied with program =Strongly agree, Improve behavior =Strongly agree	Provides constructive activities =Strongly agree
2	0.554	0.953	1.307	Involved in students' education =Strongly agree, Provides constructive activities =Strongly agree	Satisfied with program =Strongly agree
3	0.284	0.913	2.111	Available resources for family =Strongly agree, Provides constructive activities =Strongly agree, Improve behavior =Strongly agree, Students uses resources =Strongly agree	Grades improve =Strongly agree
4	0.392	0.906	1.677	Positive relationship with staff =Strongly agree, Enjoys schools =Strongly agree, Enjoys the program =Strongly agree	Improve behavior =Strongly agree

The rules determined from the parents' surveys can be seen on Table IX. These rules help the program understand how the parents feel about the program and if the program is helping their children. The first rule tells us that parents believe the program provides constructive activities when they are involved in the student's education, they are satisfied with the program and their child/ren behavior improves. It seems that improvement in their child/ren behavior is an important part in determining if the program provides constructive activities. The second rule tells us parents who are involved in students' education, and program provides constructive activities that they are satisfied with the program. The program wants the parents to be satisfied with the program because it helps grow the program. To see if the students are learning their grades would improve and from the third rule, we can see how the program is doing. If the family has resources available to them, the program provides constructive activities, students behavior improves and children using resources all lead to grades being improved. It looks like having the resources available to the family and the children using the resources have a big impact on their grades from what the parents see. The last rule tells what the parents see that leads to improved behavior. If their child/ren have a strong relationship with the staff, enjoy school and enjoy the program leads to improve behavior. If the child/ren are having a good time in school and at the program, they are usually happy.

VII. CONCLUSION

The 21CCLC program had four objectives to complete and was able to complete three out of the four objectives from this project. The creation of the master dataset wasn't created due to missing important data. Once the data has been updated for all the provided datasets it can be made. The other objectives are being met which is a success for the program. A few improvements for the future of this program are the process of collecting data to make it easier for schools to give all the data needed. When capturing the student's attendance to get the number of hours they are there, to see if students are spending the whole time or if they are leaving early. Coming up with newer questions and rewording some of the questions to make it more precise and find new relationships through associated rule mining.

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