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ASSOCIATION RULE MINING ON THE HEALTHY FOOD PREFERENCE OF HIGH SCHOOL STUDENTS: INPUTS FOR A CANTEEN MENU MANAGEMENT

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Abstract: *Sustaining the students' healthy canteen food and drinks should be a priority in every school. Students share the same predicaments as school canteens serve the same food every day without considering the choice of healthy foods that the students desire. This study employed the Knowledge Discovery on Data (KDD) technique. Ninety-seven (97) out of one hundred thirty (130) junior high school students were the respondents of the study. WEKA data mining tool was used to determine the most preferred foods by the students. The data were analyzed using R programming applying the Apriori algorithm to generate the association rules. The result shows that considering the food preference of the students is the ideal way to improve the school canteen management. The study also revealed that students prefer to eat fruits like apple, orange, mango, and meat such as chicken and pork. Moreover, fruit juices were the most preferred refreshment than water. Biscuits and breads can be served also as snacks. It was discovered that pork and chicken can be partnered to moringa leaves and squash based on the result of the association rules. Health initiative programs can be implemented in the school such as menu alterations in the school canteen based on the food preference, orienting the parents, and implementing a strict policy in selling foods or snacks within the school premises. Since schools play an essential role in influencing the students' health well-being. Therefore, school canteens should consider locally based and affordable food preference*

Keywords: Data Mining, Association Rule Mining, Healthy Food Choice, Apriori Algorithm, Canteen Management
Research Area: Human Nutrition and Public Health
Paper Type: Research Paper

1. INTRODUCTION

Every school should consider the desired choice of the students on the healthy foods served in the canteen. Nutritionally faulty and unhealthy food choices may put students at risk of malnutrition, obesity and related chronic diseases (Buzgeia, Pandey, Badr, Jahmi, & Hussain, 2007). Every student in every school shares the same concern; canteens serve the same food every day without considering the choice of healthy food that the students desire.

Schools are known to cater to the most number of people, including youth, school staff, families, and community members, hence, they can offer an imperative chance for prevention. Schools should prioritize healthy food and programs for the improvement of the student's nutritional status. It should be included in their school agenda, since there is a positive effect on the child well-being and will enhance the learning ability and academic performance (WHO, 2006). Efforts continued to promote healthy eating habits among the nation. However, the school considered those programs financially risky considering that fewer students would buy lunches.

In the Philippine context, according to Rappler (2017), the Department of Education (DepEd) has strengthened its campaign toward healthier food and beverage choices in all public elementary and high schools in the country. Last 2018, the Department launches the Oplan Kalusugan sa Department of Education (OK sa DepEd) which is a convergence of DepEd's health programs, plans, policies, and activities for their effective and efficient implementation at the school level, partnership with various stakeholders. The program focuses on the major school health and nutrition programs specifically the School-Based Feeding Program. However, the program did not consider the food preference of the beneficiaries.

Several studies have been conducted to explore the food preference of students. Park, Lee, and Kim (2015) investigated the dietary habits and food preference of elementary school students. The results revealed diverse differences in eating habits and food preferences according to the location of residence of the students in the elementary schools. They suggested that school meals should provide enough nutrients and a realistic menu plan for the physical development and health of students. Dumlao (2014) believed that often students do not visit the school canteen because of the menu. The factor influenced the food preference of the students. It is therefore believed that the food choice of the students should be considered which is vital in developing a good school canteen management, considering that the main clients are the students (Dumlao, 2014). Considering the students' demands, needs and preferences will help for a good canteen management program. Conti et, al. (2018) surveyed on the food preferences of university students and their willingness to taste foods containing terrestrial invertebrates. However, foods in the survey were not actually offered in the location of the study since the food are not admitted as food by the law.

From the review of different studies, food preferences of the students will depend on their location and school canteens should consider the food choice of the students for a better school canteen management since their main clients are the students. Thus, the study localized the healthy food options of the students, since this will not be financially risky for school canteens. Moreover, Cariaga (2012) stressed on his study that the benefits of developing healthy dietary and lifestyle patterns from early age onwards could positively affect people's nutrition and health throughout their adult lives.

Therefore, organizations and government should further explore how to provide and encourage the consumption of healthy foods. Students' acceptance of more fruits and vegetables and lower-fat foods are potential concerns. Students' food preferences will be an important component to consider in successful menu alterations.

Thus, this study will explore the healthy food choice preferences of students based on the results of association rule mining utilizing the Apriori algorithm, and what health promotion initiatives can be implemented that will not risk the financial stability of the school and the canteen.

Specifically, this study sought answers to the following research questions;

• What fruits, vegetables, meats, beverages, and snacks are most preferred by students in the School?
• What rules can be generated on the food choice preference of the students using the Apriori algorithm?
• What recommendations can be made as health promotions initiatives based on the results of the study?

2. RESEARCH METHODS

2.1. Research Design

This study also utilized the Knowledge Discovery on Data (KDD) technique. It is the practice of sifting through a very large amount of data in a particular database for useful information (Trecene, 2018). It is used also to discover trends and patterns that go beyond simple analysis. This study employed the process of KDD as shown in figure 1.

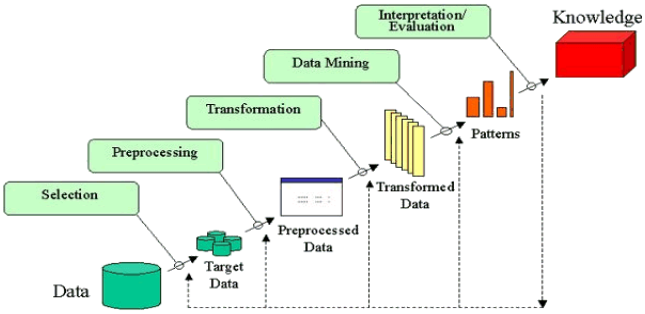

Figure 1. Knowledge discovery on data model

2.2. Data Collection

The data were collected through a survey among the students of the School. The students were asked to write their food preferences from their locality based on the following categories, (a) vegetables, (b) fruits (c) meat, (d) Beverages, and (e) snacks. Afterwards, the data were encoded in Microsoft Excel and save in a CSV format for the data analysis.

2.3. Data Pre-Processing

During the preprocessing stage, it helps improve the data by such removing food choices that were considered as unhealthy, translating the terms into English, and correcting the spellings. Moreover, answers with different spellings and terms were categorized into one.

2.4. Data Transforming

No major data transformation has been done on this stage, the responses from the participants were encoded in Microsoft Excel applications and saved in a CSV format.

2.5. Data Mining

The researcher used the Association Rule Mining technique utilizing the Apriori Algorithm. Association rules mining is one of the data mining technique which is expected to be very useful in applications (Angeline, 2013). Association rules are required to assure minimum support and minimum confidence at the same time. Association rule generation consists of two steps: First, minimum support is applied to the given set of item. Second,

using minimum confidence and frequent item sets rules are formed. Association Rules will allow to find out rules of the type: If A then B where A and B can be particular items, values, words, etc. An association rule is composed of two item sets:

1. Antecedent or Left-Hand Side (LHS)
2. Consequent or Right-Hand Side (RHS)

It describes the relationship between support, confidence and interestingness. The support and confidence are usually referred to as interestingness measures of an association rule. Association rule mining is the process of finding all the association rules with the condition of minimum support and minimum confidence. Initially, the support and confidence values are computed for all the rules and it is then compared with the threshold values to prune with low value of support or confidence.
An algorithm for association rule is the Apriori algorithm which proves to be the accepted data mining techniques in extracting association rules (Agrawal et al.,1994). The rules generated by Apriori algorithm makes it easier for the user to understand and further apply the result.

2.6. Participants Of The Study And Sampling

The participants of the study are the junior high school students of Calunangan National High School, Merida, Leyte, Philippines from the school year 2019-2020. Ninety-seven (97) out of one hundred thirty (130) population were considered as the participants of the study. Referred from the table of determining the sample size developed by Krejcie and Morgan (1970). Stratified random sampling using the proportional allocation method to determine the number of participants each strata, groups are the grade levels of the students.

2.7. Data Analysis

To identify the frequency of vegetables, fruits, meat, beverages, and snacks that are mostly preferred by the students, WEKA data mining tool was employed. According to Borkar and Rajeswari (2013), as cited by Caluza and Trecene (2018), WEKA is an open-source software that implements a large collection of machine learning algorithms for data pre-processing, classification, regression, clustering and association rules and is widely used in data mining application. Afterwards, the data were analyzed using R programming applying the Apriori Algorithm. R is a language and environment for statistical computing and graphics. R provides a highly extensible and wide variety of statistical and graphical techniques, such as linear and non-linear smodelling, classical statistical tests, time-series analysis, classification, clustering, association, and text mining particularly sentiment analysis (Introduction to R, ND).

3. RESULTS AND DISCUSSIONS

3.1. Most Preferred Vegetables, Fruits, Meat, Beverages, And Snacks

To identify the most preferred vegetables, fruits, meat, beverages and snacks by the students. The data were analyzed in the WEKA software and graphed in Microsoft Excel application.

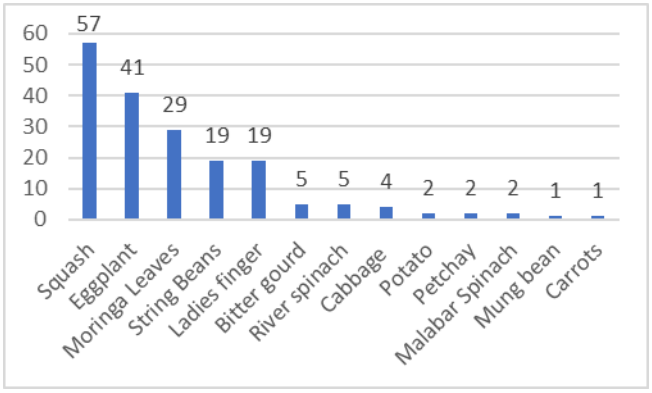

Figure 2. Most preferred vegetables of the students

The graph above shows the most preferred vegetables of the students. The results indicates that students preferred eating squash with the frequency of fifty-seven (57), followed by eggplant with the frequency of (41), moringa leaves (29), string beans (19) and ladies finger with the frequency of nineteen (19). The least chosen vegetable by the students is mung beans and carrots with the frequency of both one (1).

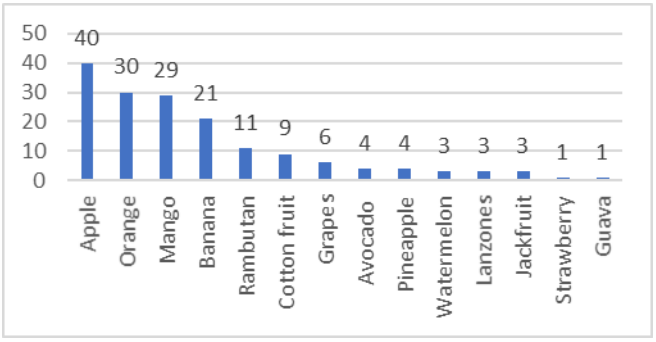

Figure 3. Most preferred fruits of the students

Fig. 3 shows that the students preferred to eat apple with the frequency of forty (40), orange (30), mango (29), banana (21), and rambutan with the frequency of eleven (11). Strawberry and guava were the least preferred fruit by the students.

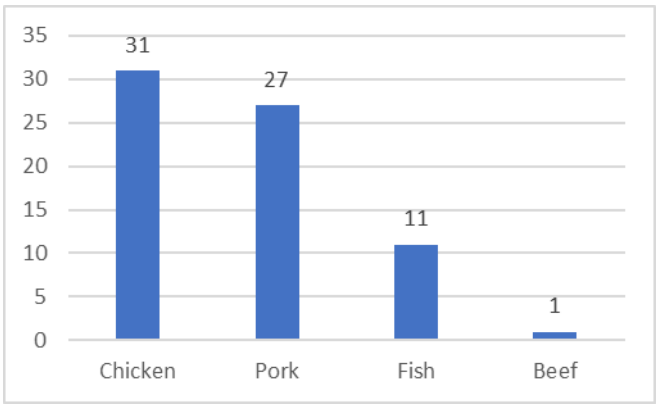

Figure 4. Most preferred meat of the students

The results from the graph show that the students prefer eating chicken and pork with the frequency of 31 and 27, respectively rather than fish and beef

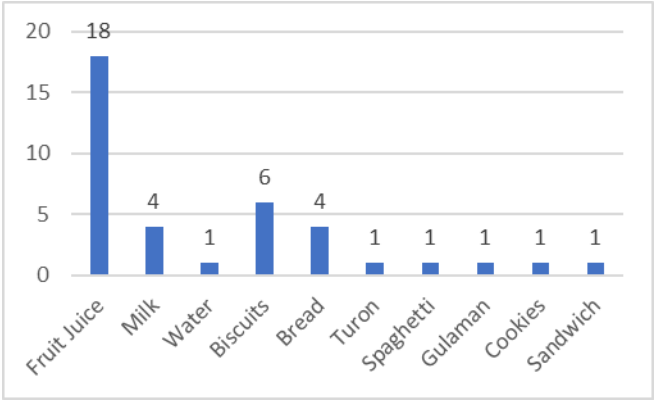

Figure 5. Most preferred beverages and snacks by the students

The above figure illustrates that the students desired to drink fruit juices rather than milk and water. Interestingly, biscuits and breads are the ideal snacks of the students.

3.2. Association Rules Generated From The Food Choice Of The Students

The data were analyze using the R programming in R Studio utilizing the Apriori Algorithm for mining frequent sets of items. Eight (8) association rules were gsenerated with the minimum support of 10.0% and minimum confidence of 80.0%.

Antecedent	Consequent	Support	Confidence	Lift
{Pork}	{Chicken}	0.2948718	1.0000000	3.000000
{Chicken}	{Pork}	0.2948718	0.8846154	3.000000
{Moringa leaves}	{Pork}	0.1923077	1.0000000	3.391304
{Moringa leaves}	{Chicken}	0.1923077	1.0000000	3.000000
{Moringa leaves, pork}	{Chicken}	0.1923077	1.0000000	3.000000
{Squash, pork}	{Chicken}	0.1923077	1.0000000	3.391304
{Squash, chicken}	{Pork}	0.1025641	1.0000000	3.391304
{Moringa Leaves, Chicken}	{Pork}	0.1923077	1.0000000	3.391304

Table 1. Association Rules based on Apriori Algorithm

As seen in table I, the following rules were made;

• If the student prefers to eat pork, then a 100.0% confidence that the student will prefer to eat chicken.
• If the student chooses chicken, then an 88.46% confidence that the student will choose pork.

• If the student prefers to eat moringa leaves, then the students will also prefer to eat pork with confidence of 100.0%.
• If the student prefers to eat moringa leaves, then the students will also prefer to eat chicken with sconfidence of 100.0%.
• If the student ideally chose to eat moringa leaves and pork, then a 100.0% confidence that the students will prefer to eat chicken.
• If the student prefers to eat squash and pork, then the student will prefer also to eat chicken.
• If the student prefers to eat squash and chicken, then a 100.0% confidence that the student will prefer to eat pork.
• If the student chose to eat moringa leaves and chicken, then a 100.0% confidence that the student will prefer pork.

It is believed that school canteens can play a pivotal role in influencing students' lives and influencing their food choices. Most adult food preference is formed during childhood so it is critical that efforts are made to significantly improve the availability of healthy food options at school (Meldrum, 2018). An ideal way is to consider the healthy food preference of the students, based on the results; students prefer to eat squash, eggplant and moringa leave as the top three most preferred vegetables by the students. Additionally, students prefer to eat fruits like apple, orange, mango, and meat such as chicken and pork, fish and beef can be least served in the canteen. Moreover, fruit juices were the most preferred refreshment than water. Biscuits and breads can be served also as snacks as the most chosen snacks by the students.

With the increasing attention posted by parents, educators, nutrition experts and society in general on the role of school canteens in promoting healthy eating, local-based foods can play a part in changing the school menu for the students, financially, this will also help the canteen not to put at risk.

4. CONCLUSION

Apriori algorithm was able to generate different association rules on the healthy food choice of the students successfully. Therefore, school canteens should consider locally based and affordable food preference. Squash, apple, chicken, biscuits and fruit juices were the most preferred foods by the students. In addition, moringa leaves and squash partnered with pork and chicken were also the ideal menus. Furthermore, schools should implement strict policy on the foods sold within the premises. Since schools play an essential role in influencing the students' health well-being.

5. RECOMMENDATIONS

Based on the results of the study, the following recommendations have been made;
• School administrators should implement a strict policy to different foods sold within the premise of the school.
• Policymakers should create a program that will orient the parents and the school canteen to serve affordable and healthy menus to the students.
• Food preference of the students should be considered for menu alterations and feeding programs.

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