Applying the Bell Curve to Demonstrate Statistical Measurement

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INTRODUCTION

Mathematics is an essential tool for student success toward graduation. Unfortunately, math literacy in public schools has been in decline for the past twenty years. Moreover, math skills have become a major obstacle for students to achieve graduation requirements through mastery of the high school TAKS exit examination. The need for better math teaching strategies is really great in order to solve this problem.

I see the solution to this by means of greater student involvement with mathematics through statistical applications. These applications can be derived from different disciplines of interest, such as geography, economics, science, or health. Middle school is a critical time in a student's academic career in order for the student to obtain a solid core of mathematical concepts to better prepare for high school and later college. Statistical applications give students good opportunities to apply algebra, graphing, and critical thinking to prepare them for those higher level skills needed later. With these skills in place in middle school, there should be greater student success in high school.

A large part of student frustration in high school math is due to a lack of mathematical fundamentals. In addition to this, many high school algebraic concepts are a leap ahead of what students have seen in middle school. If some of these concepts were presented in middle school, there may be some familiarity created that will provide high school students with the background knowledge and experience applying some of these math concepts. A large part of this background knowledge can be created by the use of practical application by students. In addition to this application base, results can be shared with other students who may gain a better understanding of statistics merely by sharing each others' work.

When students take ownership of their work, they are working toward a goal of self achievement. Development of a portfolio would be a good solution for students to see that the work they are doing is more than what the teacher desires for them to learn. Development of these portfolios comes from the information that the students themselves collect. Hopefully, this will provide greater meaning to curriculum goals of learning. In addition to this, students could share their work with others in order to gain more understanding globally in the classroom.

This unit will stimulate student application of statistics. It will demonstrate various uses of statistical measurement in various fields. Economic information, such as manufacturing or agricultural results in production, has increased mean production historically. Moreover, measurements in world population, resource distribution, weather, international trade, and productivity can be described statistically. Future probabilities can be applied as well to anticipate shortages or surplus. In addition, this information can be expanded to discussions about the state of world politics and how resources are distributed within the confines of power. Moreover, statistics can also bring about a better understanding of technological innovations which have increased mean production considerably through invention.

Through the use of the Gaussian distribution or bell curve, students can be exposed to graphing as well as probability applications. In turn, various observations can be developed that will define different distributions and, as a result, different curves. This will give opportunities for students to question relationships within distributions as the information collected changes. The normal distribution can be examined and compared to more ill defined data distributions. The potential here is to apply algebraic applications for students to use in their own models. At this point, there is a possibility that students could use the binomial probability formula and graph that distribution as a normal bell curve or a skewed curve distribution. These concepts give students exposure to high school math.

The main idea for development of this unit is to present students with sets of problems which deal with prediction and measurement. Hopefully, through diverse application of statistics, students can extend critical thinking skills in order to develop better informed decisions. Statistics and probability are tools people use to enhance decisions. Perhaps if students see the use of statistics in sports, economics, history, health, and science, they can grasp a better understanding of probability and statistics.

Additional academic benefits of this unit should be that students will learn more how to apply what they are learning in other core subjects. Students familiar with application of statistical concepts can use this knowledge to more effectively communicate social studies projects which may involve numerical research in gathering geographical or historical ideas. Students could apply statistical results of past presidential elections. They could also demonstrate social studies concepts in agriculture, resources, or manufacturing. With current information, students could apply probability theory to issues such as health, sports, or demographics. When students are familiar with how frequency distribution curves are defined, they can make predictions of outcomes due to the shape of the curve.

BACKGROUND

This unit will be designed to present students with different ways statistics is applied and measured. The first strategy is to examine the background understanding students have toward statistics. Initially there should be discussion and review about basic statistical terms, such as mean, median, and mode. Review and presentation exercises should provide the teacher with feedback of student understanding in this field. Once that feedback is made, the teacher can define a starting point of where to begin the unit.

In order to introduce the concept, the teacher should demonstrate preparation of a table with data to create an ideal Gaussian curve. The data will produce a uniform distribution so that students could understand what an ideal distribution will create in the form of the curve. The graph will show the relationship of the data distribution to the mean. It will also demonstrate the uniformity of the data for the ideal frequency distribution. Discussion of different frequencies in the data could show differences in the bell curve from the standard distribution. Students could plot their own graphs from a number of different frequency distributions put on the board by the teacher. This will enable them to have a hands-on connection to the concept.

In order to begin the unit, it would be a good start to demonstrate simple groups of numbers to develop a frequency distribution range. A simple exercise to begin this with could be to demonstrate a random coin toss. Either one of two outcomes, heads or tails, can result here. Randomness here can be defined as an even possibility of two possible outcomes.

In order to demonstrate further outcomes of greater amounts, students later could begin with a range of about seven numbers; calculations for mean, median, and mode can be calculated simply. Moreover, they can be a means to demonstrate the essence of these concepts in an

uncomplicated fashion. Using this same range of values, calculations for standard deviation and variance from the mean can be shown to students.

Once these calculations are complete, this information can be plotted and labeled on a histogram. The histogram is a concrete means to display the distribution range. Then, later students could convert the histograms to line curves to result in the distribution curve. Initially, students could plot this data on graph paper in order that they can understand where values should be shown on the graphs. Hopefully, this will give them a more in depth understanding of how the information is linked by calculation and graphically.

Since many students have basic core mathematical backgrounds, it is important to demonstrate relevance to what they will be doing with this unit. The unit should be designed to develop a wide breath of understanding using different subjects to use math for. It is hoped that through the use of statistical application, students can create better understanding in those subjects as well as the prediction and quantitative tools that they used. If students can demonstrate and share their own work, they should be able to retain that knowledge as well.

OVERVIEW

In order to introduce the Gaussian distribution curve, I think it is important to establish where the information is being defined on the X and Y axis of the distribution chart. Initially, to demonstrate the uniformity of a Gaussian distribution, a range of occurrences would be of equal value ahead as well as behind the mean number. Then, the range would be sorted and graphed on a spreadsheet to demonstrate how this curve looks and introduce concepts like variance or standard deviation from the mean. A graphic presentation of these concepts could be a good lead in for students to develop these ideas later on their own with their own data.

Each student could create a data sheet which would count the number of points scored by a basketball team per game in a season. This information would be categorized by a range of numbers between 5 and 10 points. From this data table, a mean, median, and mode could be developed. Then, the information could be sorted and plotted on a graph.

Then, students' curves could be compared and examined to stimulate questions and discussions about where the likelihood of an occurrence may be due to the shape of their curves. In addition to this, comparisons may be made to additional data, such as comparison of road and home scoring. These comparisons could lead to decisions of probability relating to movement of the mean or curve between home and road games. Moreover, studies of bell curve results could lead to discussions about what happens to the likelihood of an occurrence based on mean variance results which affect the shape of the curve as well as the tails.

There are a lot of possibilities to use this first Gaussian distribution exercise. Data can be collected for climate conditions in various places of the world, health or economic statistics, as well as past historical records for political elections. With this information, all can be categorized and demonstrated by a distribution curve. Students then should understand that distributions can change as well as their means, both of which affect probabilities of occurrences.

Economic data could be demonstrated in data tables created from food supply and consumption measurements. Students could develop distribution ranges that would demonstrate caloric intake per day for countries throughout the world. Conversely, food producing countries could be plotted to show probability that certain countries could be predicted to produce certain products in the future.

This economic data could be also used in a study of the stock market as well as determining price behavior. From this behavior students could calculate mean, median, and mode as well as plot a frequency distribution. In addition to this, students can be exposed to variance and

standard deviation from the mean calculations. These calculations will be useful to demonstrate how and why they are used because students will have different stocks to plot, this will give a way for students to compare bell curves as well as define relationships between how variance affects probability from the shape of the curve itself. By plotting the Gaussian distribution, variance measurements can be visually described to demonstrate a mathematical relationship.

When students compare different frequency distribution curves between themselves, they will be able to recognize differences in patterns of curves. This will give rise to an opportunity to introduce the concept of skewed distributions. This occurs when the distribution is not uniformly distributed like a Gaussian distribution. Due to this irregular shape, questions could arise as to why this shape behaves more skewed in certain directions than in other distributions.

Students can compare why distributions are skewed among themselves to explain each person's range data. This will demonstrate that not all distributions are normal. When there is an absence of a normal distribution, they can hypothesize as to why a distribution may be skewed in a certain direction.

ROLE OF THE TEACHER

It is desired that the role of the teacher be one as a facilitator to lead students toward creation of their work. It is desired for students to work independently on a project-based unit. The teacher will provide guidance where necessary in order to maintain quality information for students to be working with. Students would make predictions of how their outcomes should be when they are using probability. This will give them a means to compare what they think an outcome should result in compared to the reality of results. This information could be contained in a journal where students could explain as well how results deviated from their predictions.

It is important for information and a project to be relevant to student interest. This interest is the means for students to involve themselves in the data. This gives students more potential to work through a project by setting goals. By setting goals on their own, students can stay a course for completion of the work. In addition to this, it is important to share with other students in the class their results in order to exchange ideas and communicate their individual results.

Assignments will be drawn from actual scientific, political, or geographical data. This will be a means for students to understand the meaning behind their data. Students will be evaluated on how well they collect their data, synthesize it, calculate, and graphically display it. In addition to this, students will provide explanations of their results.

Lesson plans will be prepared in a logical order and sequencing of understanding. It is hoped that students will be able to learn from what they have built previously in this unit. Lessons will be designed for students to know what they are dealing with from the previous set of information in the unit. However, the overall objective of this unit is for students to become familiar with probability and statistics concepts that will enable them to be successful applying them in their future high school experience.

Students with this unit experience should be able to express themselves better mathematically. They will be using functions and algebraic expressions, make probable predictions, and explain patterns to data. Using self reliance and teacher guidance, students should be able to create meaningful projects. Moreover, students will write descriptively what they are out to accomplish and what their results mean. This communication, in turn, should create better understanding of probability and statistics.

The premise of this unit should be to have students integrate mathematics through application. Students will plot, organize distribution matrix, graph, and make comparative assumptions of data. This will enable students to generate understanding of the bell curve

application and the relationships with the frequency data. In addition, students should be able to understand what an ideal distribution is compared to the reality of random variables from recorded observations.

The benefits for students in data collection and observation will help them apply math to science observations as well. The Bell curve is the ideal application for graphically displaying a mathematical concept. In addition to this, it is a means to express relationships for one to one correspondences between numbers. It is important for the future of our society for people to reason quantitatively. The ability will result in greater worker productivity in addition to personal management.

Students should be expected to work on their individual projects on their own. Students may work in groups. However, each student should be responsible for his or her own work. The purpose of this is to encourage greater participation. Individual portfolios may be created to give the class itself a broader range of experiences. It also enables students to exchange ideas better. This process makes students develop their own unique approach to the project. It also enables the teacher to help them individually with specific problems. The final product will be easier to share with others as well as develop better understanding for the entire class.

Students should be able to use the Internet to access information to collect for plotting the curve. In addition to this, students need to be able to use the graphing capabilities of Microsoft Excel. The teacher can demonstrate how to graph using Excel before the unit. It would also be desirable for students to learn how to transfer Excel graphs to Microsoft Word. This will enable students to refer to their graphs as they prepare their written discussions of the summative project dialog.

The integration of technology is also an important use of this unit. Students should be able to use graphing and word processing to develop their work. This integration will provide useful experience for using technology as a solution to preparing projects. Technology use is a very important aspect for developing students' essential skills as well as writing for their future. One important concept to learn is the use of technology and the willingness to deal with change to adapt to ever evolving progress.

LESSONS

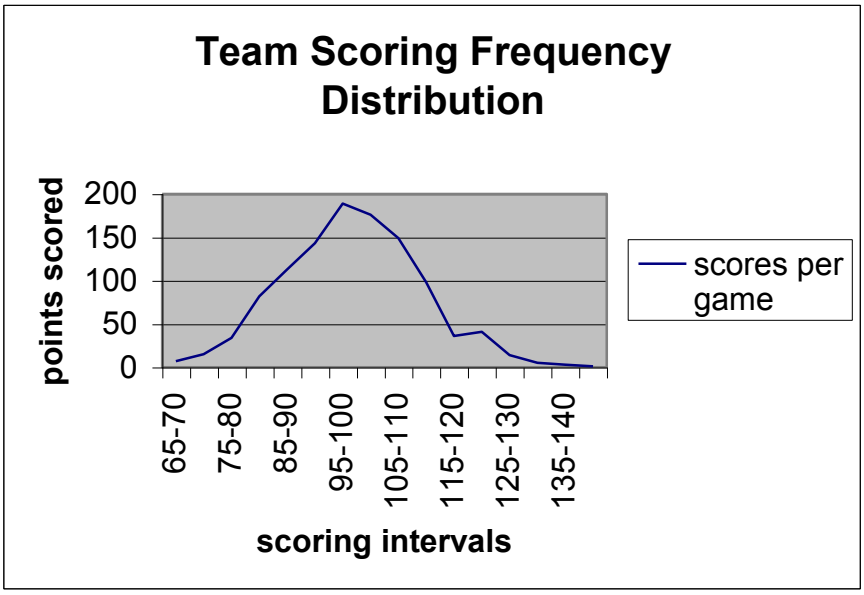
Lesson One: Basketball Gaussian Curve

One interesting lesson I came across was application of Gaussian curves using team scoring distributions for a basketball team. A team's scoring per game was recorded where intervals of 5 points resulted in a uniform frequency distribution curve with the mean at the center.

Objectives here would be for students to use applied collected data from a source. Students graphing skills should be enhanced. Students should be able to articulate and explain graphing results in a meaningful manner. Students will also measure routine statistical measurements, such as mean, median, and mode. Comparisons could be made between the mean and the center of the distribution curve. Students could explain the difference of their results from a normal distribution to their own distribution.

In a classroom, students can gather information about a team on their own. For example, access to the Internet website www.nba.com can gain access to professional team statistics. Trying it out, I selected one team, the Dallas Mavericks, at http://www.nba.com/mavericks/schedule/. By accessing a team's schedule, scoring information for each game can be obtained. Then each game can be categorized by the amount of points scored within 5 point intervals. Once categorized a distribution curve can be derived by graphing points scored intervals of 5 points on the X axis and the quantity of games where each point distribution had scores as the Y axis.

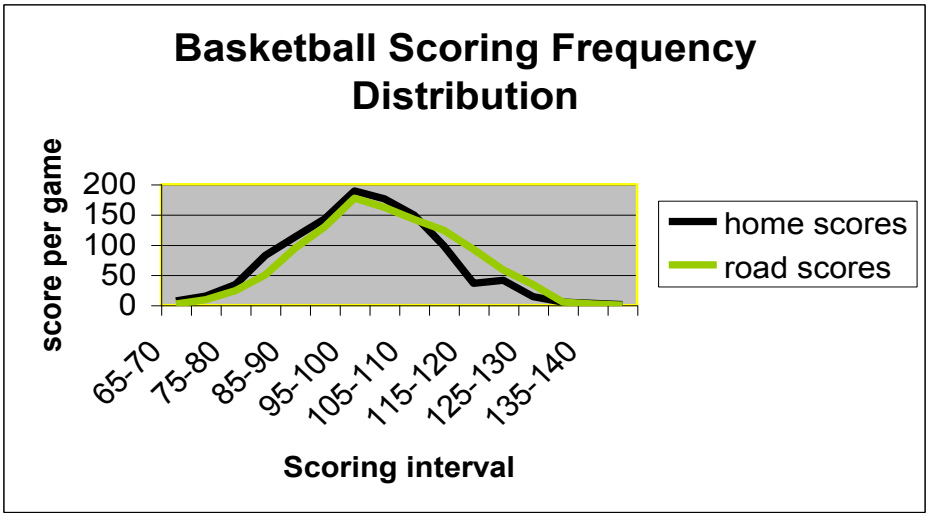
Students can use the internet to get their own information for the team of their choice, collect and organize the scoring information by 5 point interval, and graph it.



Once graphs have been completed, students could label and print their graphs. Questions could be poised as to whether the scoring distribution was normal or not. How did the curve look? Was the distribution curve narrow with a short tail on the ends? Could the curve be rather flat where tails are longer? For which point intervals is the probability the greatest and least for scoring? What happens to the curve when mode and median numbers varies?

Students can be evaluated for their organization of the data and plotting of graphs. Additional evaluation can be done by how well they analyzed the data and explained answers to questions about it.

The unit can be expanded by students plotting scores separated by home and road games. From this information, distributions could be recorded and graphed where students could compare means and scoring frequency between home and road games. This could lead to discussions of mean changes, height or flatness of distribution curves, and scoring probabilities within intervals.



Lesson Two: Stock Market Variance

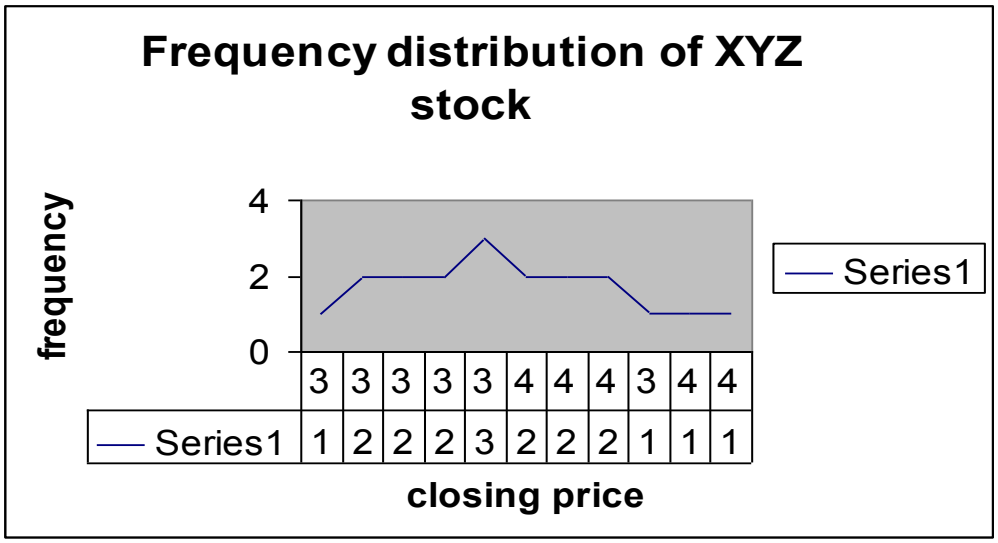
Variance computation- Students can apply bell curve concepts to stock market trading. Stocks can be tracked and categorized into distributions over a period of time. Theories such as variances from the mean can be applied for students to understand opportunities for stock purchase.

XYZ stock	close price	(X-mean)
4/11/2006	34	-4
4/12/2006	42	4
4/13/2006	34	-4
4/14/2006	37	-1
4/15/2006	44	6
4/16/2006	41	3
4/17/2006	35	-3
4/18/2006	38	0
4/19/2006	39	1
4/20/2006	44	6
4/21/2006	42	4
4/22/2006	41	3
4/23/2006	40	2
4/24/2006	37	-1
4/25/2006	45	7
4/26/2006	33	-5
4/27/2006	35	-3
4/28/2006	37	-1
4/29/2006	33	-5
mean	38	

In order for students to gather data, each can select a particular stock closing price over a period of time such as a year. Students can research this information by going to Yahoo Finance. At Yahoo Finance, students can graph certain stocks as well as download historical closing prices within any span of time of their choice to an Excel spreadsheet. Then, the downloaded spreadsheet can be converted from a CVS format to Excel file. The purpose of this is so that numerical data can be understood as converted from Excel.

Graphing closing price frequency distribution

Once the historical array is in place, the next lesson will have the students reorganize this information to suit a number of needs. In order to determine a closing price frequency distribution, closing prices can be sorted from least to greatest. Then, those could be counted within intervals in order to plot the Gaussian curve.



Probability assumptions using Gaussian curve for stock prices

Probability can be inferred by using a Gaussian curve. Students can make inferences for the likelihood of an event using the curve as a reference point. For example, using a bell curve for stock prices, students could evaluate the frequency of a price occurring in a range of time. The objective for students is to ask whether it is a good time to buy or sell a stock based on its historical behavior.

The likelihood of a closing price falling in the tails of the curve is less frequent than in the larger body of the bell. Should students sell their stock if the closing price is rising to the more narrow advanced part of the curve? Should they sell based on a stock moving closer to the more narrow lesser part of the curve? Students can examine a stock's daily closing price to compare its probability. The question should be to buy or sell this stock based on its trading history. Students could create a log of their stock transactions along with the probability arrived at from that stock's Gaussian curve.

Lesson Three: Writing about Results

There should be a conclusive narrative made by students to explain what their observations were of the Gaussian curve. The integration of writing is an important component of this unit as students will summarize all of their predictions, observations, and results. Student's written work is a means of both learning and communication.

The basis for this is that students will learn to communicate in written form what they have learned. This is an important skill to learn and enhance. Writing not only communicates what has been learned, but the written application helps students retain their knowledge of the subject matter better. It is a means for students to reflect on the work that they had done too. Writing enables students to digest and reflect on what has been learned. It also promotes discussion with other students over what has been learned.

In addition to this, writing is a means of exchanging ideas with other students. Students could create a portfolio book for the class that could be used to show each other what they did. Students will keep journals where they record predictions and results for the data they are collecting. Moreover, students' writing compositions could be converted to a class website. The website could be a means to show what previous classes did in their work too.

CONCLUSION

In a time of declining math scores and more at risk students in high schools, it appears necessary to find alternatives to traditional mathematics instruction. With coming of the No Child Left Behind legislation, it is very important to involve students toward future mathematics success in high school. I think the more involved students are themselves, the more they are likely to develop good working skills. These skills will better prepare students in middle school for high school math. It is critical for students to get a solid foundation in mathematical skills in middle school. If students were better prepared in middle school, they would less apt to be frustrated in high school. The more engaged students are with math applications, the more they will be willing to practice. In turn, this practice will enable them to be better at the subject without the frustration of dealing with failure.

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