Teaching the Topic of "Expected Return and Risk" Through the Art of Storytelling

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Abstract

Even at undergraduate level, rote learning is common among students. I have seen students mugging up concepts and mechanics of solving numerical problems without understanding the true meaning of such concepts. There could be many reasons for such behaviour of students but as a teacher, I take it as my responsibility to teach in such a way that students do not need to mug up and rather, understand the concepts in their true sense. In this endeavour, I have written a story to teach the topic of "Expected Return and Risk" and I believe that students would gain an insight into the topic whereby the need to do rote learning will be done away with. The said story is presented in this article along with a game that is inbuilt in this story. I recommend that teachers should use this story for teaching this topic during their lectures and reap its benefits. The mechanics of the game have been explained for reference of teachers. The game can be played by students within the lecture as part of their learning.

Keywords: rote learning, storytelling, learning through games, classroom lecture.

Introduction

It is widely believed that the human brain is programmed to organize thoughts in the form of a story (Hardy (1977), Fuller (1982), Lanzara (1990), McLeod (1997), Gabriel (2000), Denning (2004). We tend to understand concepts and ideas better when we weave a story around them. I have often observed while teaching the subject of finance that students learn a few concepts mechanically and find it challenging to understand the real meaning and interpretation thereof. Two such concepts are "Expected Return and Risk in an Investment" and "Relative Risk among Investments".

In this article, I present a story titled "Demons' Treasure" that involves a game which can be played by students collectively and is useful in making them understand the said two concepts in their true sense. The story has been divided into two parts. Part one of the story is helpful in teaching the concept of expected return and risk while part two is helpful in teaching the concept of relative risk among investments.

Procedure

The steps involved in the activity are as follows:

Step 1

To start with, the instructor should specify the objective of part one of the story, that is, the students should be able to compute expected return and risk on an investment and understand the true meaning of those concepts. After that, part one of the story should be narrated to the students.

Part One of Story

Once upon a time, there was a kingdom under the rule of a noble king. The people in the kingdom were happy under their king's rule. The king was more of a saint who was not attracted by wealth and led a simple life. He imposed very less taxes on people and maintained just the minimum required treasury. It so happened that the kingdom received scanty rainfall for three years in a row, which resulted in a very low agricultural production. The king opened gates of treasury for buying food grains from neighbouring states. With time, the treasury was getting depleted and was a major cause of worry for the king. He called a meeting of his ministers to discuss the crisis. During the meeting, no one could suggest a solution to the problem. It was then, that one of the ministers suggested something, which everybody knew about but dared not to speak, for the feat was feared impossible.

There was a hill just outside the kingdom's boundary where two demons used to live. They used to guard two caves on the hill which supposedly contained a huge treasure. The demons had, for long, thrown an open challenge that one who would dare to face them could have the treasure. No one, either from this kingdom or any of the neighbouring states, had ever tried for the demons' treasure.

The minister, in the meeting, had suggested that someone from the kingdom should go to the hill, face the demons and try for the treasure. The king, on listening to the proposal, was reluctant in accepting it because the proposal would put his subjects' life in danger. However, after much deliberation, it was concluded that the proposal should be given a try and an announcement be made in the kingdom for inviting volunteers for the purpose.

The announcement was made and in response to it, an old couple, along with their son and daughter visited the king the same day. The old couple pleaded the king to allow their kids to try for the feat. The king, in dismay, asked the couple, "Why do you want these young kids to go to the hill? Don't you fear for their lives?" The father of the kids replied, "My lord, our kingdom is in distress. It needs its brave and wise young blood at this time. I have raised my kids free from any fear and I don't worry for their life because I believe that brain is mightier than brawn." The king then asked the mother, "Do you agree with your husband?" The mother replied, "Yes, my lord. This feat can be accomplished only with wisdom and God's grace. I have full faith in my kids. They complement each other so well that no one can harm them till they are together." The king was amazed at the confidence of the couple and decided to send the kids for the demons.

The brother and the sister took along some food and weapons and left for the hill on their horses. On reaching the hill, they studied from a distance, the caves and the demons guarding them. The demons were huge in size with fiery red eyes, long coarse hair and sharp nails.
Brother: "It's obvious why no one has ever attempted this feat before."
Sister: "Don't worry brother; I will take care of you. Let's go and meet them."
Brother: "Oh yes, I have come here relying on you, sister."

Both reached the caves and stood face to face with the demons, with swords pointing towards them. The demons were surprised, for no human has ever ventured onto their hill ever. The heartbeat of both the kids became fast but they kept their calm and waited for the demons' move. To their surprise, the demons stood still for some time, apparently in a shock, and then burst into laughter, "Ha..Ha..Ha..Ha…..", congratulating each other that finally, someone has come to face them. The kids got confused over the demons' reaction and looked at each other in disbelief, though fully alert for any sudden move. After the demons came back to their senses, they told the kids that they have been waiting for someone for long and did not mean any harm.

Demon1: "Don't worry and don't fear us. We won't harm you. We have been alone here for so long that we are happy to see you. We want to welcome you and invite you for playing an entertaining game with us."
Demon2: "Yes, we do, really!"
Brother: "But what about your challenge? You have thrown an open challenge that, who so ever wants the treasure, would have to face you."
Sister: "Yes, don't try to fool us."
Demon1: "Of course, we have thrown the challenge and you have accepted it. Here you are, facing us. Just play a game with us and you could win the treasure."
Demon2: "Yes, you could, really!"
Sister: "Is that all? You just want to play a game and nothing else?"
Brother: "It couldn't be that simple, sister. I don't believe him."
Demon1: "Well, it is this simple. You humans have an inherent trait to value complex things and render simple things as worthless."
Demon2: "Yes, you do, really!"
Brother: "Alright, let's say we believe you. What is the game then?"
Sister: "Yes, explain the game to us first."
Demon1: "Alright. The game is like this: We will put some chits in an urn and you will draw one from it. You will get whatever is written on that chit. It's simple."
Demon2: "Yes, it is, really!"
Brother (to Demon1): "What is it with your partner? Is 'really' all that he can say?"
Sister: "He appears to be a bit dumb."
Demon1: "Oh yes, he is like that only. Don't mind him. But thanks, though, for not finding me dumb."
Sister: "Alright, let's play the game then."
Demon1: "It would be better if you point your swords down. There is no need for these."
Both, the brother and the sister withdrew their swords and stood at ease.
Demon1: "Now, let's prepare the chits. There will be ten chits on which the number of gold coins will be mentioned. If the number on a chit is positive, you will receive the coins but if the number is negative, you will have to pay those many coins to us."
Brother: "But we do not have any coins to start with."
Demon1: "Never mind, we will play ten rounds of the game and then settle the coins at the end."
Brother: "What if, after the ten rounds, we still have to pay the coins to you?"

Demon1 (while looking at the other demon and giggling): "Well, because you don't have any coins, we will make up for that by feasting on you."

Sister (while signalling her brother): "Okay...That's fine. We agree."

Brother (on getting the signal): "Okay. Let's play then."

Sister: "But who will prepare the chits?"

Demon1: "I will."

Sister: "Alright, since it is your game, you prepare the chits."

The demon wrote the following numbers on ten chits: 1,000,000 coins on two, 700,000 coins on three, 400,000 coins on two, and 200,000 coins on three chits."

Sister: "But there are no negative signs on any of the chits."

Demon1: "Oh, I forgot that."

Sister: "Allow me to help you in putting the signs."

Demon1: "Alright, you put the negative signs on five of these chits."

She, cleverly, put the negative signs on three chits that had 200,000 coins and two chits that had 400,000 coins mentioned. So now, the chits were as follows:

Table 1: Chits in the game

Number of coins	Number of chits
1,000,000	2
700,000	3
- 400,000	2
- 200,000	3
Total chits	10

The sister immediately computed the expected winning or the average winning per draw like this:

Table 2: Expected winning per draw

Number of coins	Number of chits	Probability	Number of coins*Probability
1,000,000	2	2/10 = 0.2	1,000,000 * 0.2 = 200,000
700,000	3	3/10 = 0.3	700,000 * 0.3 = 210,000
- 400,000	2	2/10 = 0.2	- 400,000 * 0.2 = - 80,000
- 200,000	3	3/10 = 0.3	- 200,000 * 0.3 = - 60,000
Total	10	1.0	270,000

The expected winning per draw was estimated as 270,000 coins.

She went to her brother and whispered to him that he could play the game comfortably as the expected winning in ten draws is 2,700,000 coins (i.e., 270,000 coins * 10 draws). Listening to this, the brother's confidence boosted.

Brother: "Now, let's start the game."

Demon1: "Sure. Who will play first, you or her?"

Brother: "Me."

Demon1: "Okay. So, draw one chit and show it to me."

He drew a chit, on which - 200,000 coins was written. The demon laughed out loud and noted the number on a paper. The chit was put back into the urn and then, the second chit was drawn. This time, a chit with - 400,000 coins was drawn and both the demons laughed out even louder. The chit was again put back into the urn and a chit with 700,000 coins appeared in the third draw. This time, the brother smiled and looked at his sister who nodded with an assurance. The demon kept on noting down the numbers drawn on the paper. The process was repeated seven more times at the end of which the number of coins noted on the paper were as follows:

Table 3: Actual chits drawn

Number of coins	Number of draws
1,000,000	2
700,000	2
-400,000	4
-200,000	2
Total draws	10

The demons had a laugh six times out of the ten draws.

Brother (to Demon1): "So, how have I fared?"
Demon1: "Let's see?"
The demon computed the coins won/lost by the brother like this:

Table 4: Winnings of the brother

Number of coins	Number of draws	Number of coins * Number of draws
1,000,000	2	1,000,000 * 2 = 2,000,000
700,000	2	700,000 * 2 = 1400,000
- 400,000	4	- 400,000 * 4 = - 1,600,000
- 200,000	2	- 200,000 * 2 = - 400,000
Total	10	1,400,000

The brother had won 3,400,000 coins in a total of 4 draws whereas lost 2,000,000 coins in a total of 6 draws, resulting in a net winning of 1,400,000 gold coins in the game. The demons were unhappy and immediately insisted on playing the game once more, but this time, with the sister.

Brother: "Wait. Before we start the next game, I want to discuss something with my sister."
At that time, to everyone's surprise, the second demon spoke something relevant for the first time.
Demon2: "Yes, let's take a short break. I also want to talk to my partner."

The demons went to one corner to talk while the brother approached his sister and asked, "What happened sister? You said that our expected winning was 2,700,000 coins but we actually won only 1,400,000 coins. Why was there a variation?"
Sister: "Of course, there would be a variation. This is a game of probabilities. The expected winning of 270,000 coins per draw does not mean that the winnings would be exactly 2,700,000 coins in a game of 10 draws. It could be less than 2,700,000 or more than 2,700,000 in a particular game."
Brother: "Then how should the expected winning be interpreted?"
Sister: "The interpretation of the expected winning is like this:
In any one draw, either 1,000,000 or 700,000 or - 400,000 or - 200,000 coins would result. A player cannot win 270,000 coins in any of the draws because it is not mentioned on any of the chits. However, if the chits are drawn for a sufficiently large number of times, then the average winning in all those draws would be about 270,000 coins per draw."
Brother: "This means that in the second game, which you will play now, there is again a variation possible."
Sister: "Yes."
Brother: "How much of a variation is possible?"
Sister: "Well, we can compute the possible variation through standard deviation, which is a measure of such variation. If you want, I can compute it for you."
Brother: "Okay. Then compute it quickly."
Sister: "First, we will compute possible deviations that can occur from the expected winning of 270,000 coins per draw, like this:

Table 5: Computation of deviations from mean

Number of coins	Probability	Deviations
1,000,000	0.2	(1,000,000 - 270,000)
700,000	0.3	(700,000 - 270,000)
- 400,000	0.2	(- 400,000 - 270,000)
- 200,000	0.3	(- 200,000 - 270,000)
Total	1.0	

Brother: "Okay."
Sister: "Then, we will square these deviations, like this:

Table 6: Square of deviations

Number of coins	Probability	Deviations^2
1,000,000	0.2	$(1,000,000 - 270,000)^2$
700,000	0.3	$(700,000 - 270,000)^2$
- 400,000	0.2	$(- 400,000 - 270,000)^2$
-200,000	0.3	$(- 200,000 - 270,000)^2$
Total	1.0	

Brother: "Okay."

Sister: "Then, we will multiply these squared deviations with their respective probabilities, like this:

Table 7: Square of deviations times their probability

Number of coins	Probability	Deviations^2	Probability * Deviations^2
1,000,000	0.2	$(1{,}000{,}000 - 270{,}000)^2$	$0.2 * (1{,}000{,}000 - 270{,}000)^2$
700,000	0.3	$(700{,}000 - 270{,}000)^2$	$0.3 * (700{,}000 - 270{,}000)^2$
- 400,000	0.2	$(- 400{,}000 - 270{,}000)^2$	$0.2 * (- 400{,}000 - 270{,}000)^2$
-200,000	0.3	$(- 200{,}000 - 270{,}000)^2$	$0.3 * (- 200{,}000 - 270{,}000)^2$
Total	1.0		

Brother: "Okay."

Sister: "The sum of this last column is known as the variance and the square root of this variance is the standard deviation. It can be computed like this:

Table 8: Computation of variance and standard deviation

Number of coins	Probability	Deviations^2	Probability * Deviations^2
1,000,000	0.2	$(1{,}000{,}000 - 270{,}000)^2$	$0.2 * (1{,}000{,}000 - 270{,}000)^2$
700,000	0.3	$(700{,}000 - 270{,}000)^2$	$0.3 * (700{,}000 - 270{,}000)^2$
- 400,000	0.2	$(- 400{,}000 - 270{,}000)^2$	$0.2 * (- 400{,}000 - 270{,}000)^2$
-200,000	0.3	$(- 200{,}000 - 270{,}000)^2$	$0.3 * (- 200{,}000 - 270{,}000)^2$
Total	1.0		Variance = 318100000000
			Standard deviation $=(\text{Variance})^{1/2}$ $= (318100000000)^{1/2}$ $= 564{,}003$ coins

Brother: "The standard deviation is 564,003 coins."

Sister: "Yes. This means that the expected winning of 270,000 coins per draw may vary by 564,003 coins, that is, it would most probably lie in the range of 834,003 (i.e., 270,000 + 564,003) to -294,003 (i.e., 270,000 - 564,003) coins."

Brother: "Does this mean that the winning of 10 draws could lie within a range of 8,340,030 coins to – 2,940,030 coins."

Sister: "Yes. Our winning of 1,400,000 coins in the game lies within this range. In fact, you have played well."

Brother: "Oh my God, I would say that I was lucky because there is nothing much that you can do when the game is based on probabilities. In fact, the credit should go to you because you chose to put the negative signs on the lower value chits. Otherwise, the chances of winning coins would have been even lesser."

Sister (signalling to keep quiet): "Hush..."

The story can be read out aloud and I believe that a story is best told when a narrator sheds her/his inhibitions in classroom and expresses emotions in the story as if the story is being told to a five year old kid. The instructor may laugh out loud when the demons laugh in the story and a smile will appear on faces of all students in the class. This way, the whole exercise would become enjoyable for both – the students as well as the instructor.

The table defining the number and denomination of chits (that is, table 1) in the game can either be shown to students through a projector or can be written on a board by the instructor. I prefer that the table is written on the board so that the same table can continue to be used further for computing the expected winning in the game.

After the instructor is done narrating part one of the story, she/he should ask the students to play the game in the same way as it was played in the story. All the students should be asked to prepare chits out of a sheet of paper just as it were in table 1 in the story. Each student should draw one chit at a time and note down her/his winning on a sheet of paper. The chit should be drawn ten times as it was in the story and every student should be asked to compute her/his total winning in ten draws. After all students have computed their total winnings, they should be asked to disclose their winning before the class. It will be observed that some students have scored more than 14,00,000 coins while others have scored less than 14,00,000 coins. The students will observe the variabilty in their winnings and will be able to understand how the actual result could be different even when they are playing the same game.

At this point, the students should be told that in the world of investments, the gold coins in the story get replaced with the return on investments in percentage and the expected return on an investment is estimated just like the expected winning was computed in the games in the story. The standard deviation in the winnings of the games is similar to the risk involved in investments. After that, the second part of the story should be narrated to the students.

The instructor should state the learning objective of part two of the story, that is, after listening part two, the students should be able to compute relative risk and make a comparison on the basis of relative risk.

Part Two of Story

The demons were also done with their discussion and they returned to play the game once more.

Demon2 (to the brother): "You were able to win in the last game because the girl had put the negative signs on the lower value chits. I think that we should change the chits this time."
The sister was amazed that the dumb looking second demon was not that dumb after all. He could make out what happened in the last game.
Sister: "Alright, as you say. Let's prepare new chits for the second game."
Demon2: "Fine. This time, I will put the signs on the chits."
Sister: "Okay."
The demon prepared four chits with 1,200,000 coins, 900,000 coins, 400,000 coins, and 200,000 coins written on them and this time, he put negative signs on the chits with 1,200,000 coins and 900,000 coins. After doing so, he laughed out loud and said, "Now, I will see who wins."
Sister: "Since, you have prepared four of the chits, allow me to prepare the rest."
Demon2: "Okay, but don't change the denominations."
Sister: "Of course not."
The sister had to prepare six more chits and the best that she could do was to write 400,000 coins on all of them. So now, the ten chits appeared like this:

Table 9: Chits in second game

Number of coins	Number of chits
200,000	1
400,000	7
- 900,000	1
- 1,200,000	1
Total	10

The brother immediately computed the expected winning per draw like this:

Table 10: Expected winning in second game

Number of coins	Number of chits	Probability	Number of coins * Probability
200,000	1	1/10 = 0.1	200,000 * 0.1 = 20,000
400,000	7	7/10 = 0.7	400,000 * 0.7 = 280,000
- 900,000	1	1/10 = 0.1	- 900,000 * 0.1 = - 90,000
- 1,200,000	1	1/10 = 0.1	-1,200,000 * 0.1 = - 120,000
Total	10	1.0	Expected winning = 90,000 coins

He also computed the standard deviation like this:

Table 11: Computation of variance and standard deviation in second game

Number of coins	Probability	Deviations^2	Probability * Deviations^2
200,000	0.1	$(200{,}000 - 90{,}000)^2$	$0.1 * (200{,}000 - 90{,}000)^2$
400,000	0.7	$(400{,}000 - 90{,}000)^2$	$0.7 * (400{,}000 - 90{,}000)^2$
- 900,000	0.1	$(- 900{,}000 - 90{,}000)^2$	$0.1 * (- 900{,}000 - 90{,}000)^2$
- 1,200,000	0.1	$(- 1{,}200{,}000 - 90{,}000)^2$	$0.1 * (- 1{,}200{,}000 - 90{,}000)^2$
Total	1.0		Variance = 332900000000
			Standard deviation = $(\text{Variance})^{1/2}$ $= (332900000000)^{1/2}$ $= 576{,}975$ coins

Brother (whispering to her sister): "This time, the expected winning per draw is just 90,000 coins with a standard deviation of 576,975 coins."

Sister: "This demon has played smart. Let's see what happens after 10 draws."

Demon2: "Shall we start?"

Sister: "Yes."

She drew the first chit and it was - 1,200,000 coins. The second demon laughed out loud. She drew the second chit and it was again - 1,200,000 coins. She couldn't believe it. The demons started dancing together. The sister looked at her brother in dismay and he signalled her to be calm. He held his sword's hilt tight and asked her not to worry. She prayed to God and drew the other eight chits. The result, after drawing the ten chits was like this:

Table 12: Winnings of sister in second game

Number of coins	Chits drawn	Number of coins * Chits drawn
200,000	2	200,000 * 2 = 400,000
400,000	6	400,000 * 6 = 2400,000
- 900,000	0	-900,000 * 0 = 0
- 1,200,000	2	- 1,200,000 * 2 = - 2400,000
Total	10	400,000

On realising that she had not lost and rather won 400,000 coins, the sister screamed out loud, "Yes..... Thank you God!"

Demon1 got baffled at this loss. In desperation, he ran towards the girl to kill her but Demon2 stopped him while the kids drew their swords and took positions to defend.

Demon2 held his partner firmly saying, "No partner, we might be demons but we also have a code of conduct. If we have lost, let's accept it. The kids have been both - smart as well as lucky."

Demon1 to Demon2: "But we don't have these many gold coins in the treasure to pay them, partner."

Brother: "What? What do you mean?"

Demon2: "Well, actually, there are only 1,500,000 gold coins in the cave whereas you have won a total of 1,800,000 gold coins in the two games (i.e., 1,400,000 in the first game and 400,000 in the second one)."

Sister: "Really!"

Demon2: "Yes, we could have never imagined that someone could win even more than the total treasure itself."

Brother: "But how do you know that there are exactly 1,500,000 gold coins in the treasure."

Demon2: "What do you think we have been doing on this hill for so many years?"

Sister: "Okay. You intended to eat us up if we were not able to pay gold coins to you. Now, what do you say, what should be done with you since you are short by 300,000 coins?"

Demon2: "That is for you to decide."

Sister: "Well, if that is so, then I would say that you will remain indebted to us for life, never try to attack our kingdom and rather promise us that you will fight for us in case of a war with any other kingdom."

Demon1 to Demon2: "This girl is playing smart, partner."

Demon2: "Well, I would say that these kids are much wise for their age. I promise you all that you say, girl. Now, you can leave with the treasure."

The brother and sister left the hill with the treasure on their horses. While returning, both were thinking and discussing of all that had happened. After a while, they came to their usual self and started arguing about whose game was riskier.

Brother: "Though both the games were risky, I think that the first game that I played was riskier than the second game that you played."

Sister: "Of course, whatever you do has to be much grander than what others do."

Brother: "Why, was it not?"

Sister: "Of course not. Risk can be defined as the possibility of a variation in the expected outcome and standard deviation is a measure of such a variation. If you remember, the standard deviation was higher in the second game."

Brother: "Yes, it was. This means that a higher standard deviation always means a higher risk."

Sister: "Well, not necessarily. While making a comparison, the standard deviation is to be compared in relation to the expected outcome, that is, we have to compare the relative risk instead of the absolute standard deviation."

Brother: "Relative risk?"

Sister: "Yes. One of the measures of relative risk is the 'Co-efficient of variation'."

Brother: "What is that?"

Sister: "Co-efficient of variation is computed as the standard deviation divided by the expected outcome, like this:

     Co-efficient of variation = Standard deviation/Expected outcome"

Brother: "Let me compute this co-efficient for our games.

     For game 1 (played by the brother): 564,003 coins/270,000 coins = 2.09

For game 2 (played by the sister): 576,975 coins/90,000 coins = 6.41

Your co-efficient of variation is much higher than mine."

Sister: "Yes. This proves that my game was much riskier than yours."

Brother: "Okay. So, you were the real Hercules."

Sister: "Oh come on! You started it. There is no need of a comparison."

Brother: "Of course, sister. I was just passing time."

Sister: "Let me tell you one thing."

Brother: "What?"

Sister: "The co-efficient, as a proof, was not needed at all for deciding the riskier game in our case."

Brother: "Why?"

Sister: "Because as compared to your game, the expected winning was lower in my game besides the higher standard deviation. So, it was anyhow, relatively riskier. We need to compute the co-efficient of variation only if the standard deviation is higher along with a higher expected outcome."

Brother: "Okay."

Sister: "If there were a choice to play any one game out of the two, we would not have chosen the second game because of its higher relative risk."

Brother: "This means that a lower co-efficient of variation is preferred."

Sister: "Yes."

They kept on discussing about their venture and how everyone will be happy in their kingdom on their arrival.   (The end of story)

At the end of story, the instructor should tell students that while comparing two investment proposals, co-efficient of variation is used as a measure of relative risk just like it has been used in the story to compare the risk involved in two games.

Conclusion

It is our duty as teachers that we keep on improving the way we teach our students with the objective of making the subject being taught easy for them to understand. I believe that the story presented in this article would be able to make the topic of "Expected return and risk" easier for students to grasp in its true sense and would do away with the need for rote learning, at least for this topic.

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