Quantitative Reasoning Applications and Modelling in The Real World at Zayed University

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Abstract
Developing a link between student's mind and real life problems that can be solved mathematically is the main objectives of many educators and mathematics teachers all over the world. This objective can be achieved to a great extent through improving student's attitude toward mathematics, make mathematics a live, easier and an attractive subject. It can be feasible if we can improve the quantitative reasoning ability of the students, as well as improve their computational skills. This paper is considering to introduce quantitative reasoning courses at Zayed University, the learning out comes of these courses will provide students with a broad general education in quantitative reasoning and critical thinking. To achieve this, the courses designed to focus on analytical reasoning and thinking to solve real world problems in business, finance, economics, computer science, education and the natural sciences; this is handled through classroom activities and projects to introduce the students to various topics. In conclusion, examples from my current Developmental Math classes gave preliminary indication of promising results, and encouraging considering designing quantitative reasoning courses.

Introduction
For the past 9 years at Zayed University, my self and almost all mathematics teacher at Natural and Quantitative Science Department have been thinking deeply and actively about ways to improve student's attitude toward mathematics.

Teaching mathematics in an innovative way to undergraduate students could be achieved via collaborative and cooperative teaching and learning method.

To achieve this it was essential to build up students understanding of their relation to the world, also to prepare students to think critically.

After some thoughts about effective integration of real life problems into the mathematics curriculum; adopting a new philosophy and methodology of emphasis on applications of mathematics in the real world; teaching mathematics through problem solving, concept and theory to follow, beside all that knowing that Quantitative Reasoning courses need more time on real life problems and interactive classes, the University now planning to construct new sequences of QR courses with new learning outcomes, and more real life problems involved into fulfilling its goals of critical thinking and quantitative reasoning.

Quantitative Reasoning
In her paper " The Role of Mathematics Courses in the Development of Quantitative Literacy" Prof. Deborah Hughes Hallett[(1)] described Quantitative literacy as a Habit of Mind, when she said that Quantitative Literacy is the ability to identify, understand, and use quantitative arguments in everyday contexts.
With this in mind, and knowing that *Quantitative Reasoning* is the process of explore, display, judging and reaching conclusions from quantitative information, there are many aspects to quantitative reasoning, like exploitation and design of some mathematical models that represent quantitative information; the treatment, analyzing and handling of these models; followed by

outcomes and conclusions, then predictions depending on the analysis made, and finally the assessment of how reasonable are these conclusions.
Quantitative Reasoning is essential in almost all academic grounds, is crucial for making decisions in real life problems, and is used in every line of work and careers.
According to the Mathematics Association of America (MAA)[(2)], the basic skills and capabilities in Quantitative Reasoning should be established for all students who receive a bachelor's degree, graduates are expected to be able to apply simple mathematical methods to the solution of real-world problem.
Also Quantitative Reasoning course should be handled carefully, at appropriate times and in appropriate ways. Assessment too should reflect course goals and teaching methods used.

Quantitative Reasoning Courses Learning Outcomes

Quantitative Reasoning encompasses abilities necessary for a student to become quantitatively literate in today's technological world.
Most higher education institutions include among its learning goals for its students quantitative reasoning. Very often, both critical thinking and quantitative reasoning (or QL) will be listed as goals.
We too at Zayed University as a "Laptop University" our students will be able to apply information technology tools and skills in an ethical way. Learning Outcomes for a Quantitative Course can be summarized as follows[(3)]:

Students will understand the impact of quantitative reasoning and mathematics on the sciences, society and one's personal life and the need to apply suitable quantitative methods to solve real-world problems.

Students will be able to apply the logic of reasonableness to interpret, express and manipulate quantitative information in forms such as verbal, numeric, graphical and symbolic.

Students will be able to interpret mathematical or statistical models such as formulas, graphs and tables and draw inferences from them.

Students will be able to use appropriate technology to evaluate, analyze and synthesize information in problem solving situations.

Students will be able to make estimates and check answers to quantitative problems in order to identify alternatives and critically evaluate their reasonableness and limits of validity.

Suggested Example for a new Quantitative Reasoning Course

A course in Quantitative Reasoning is to be designed to provide students with a broad general education in quantitative reasoning and critical thinking. It will also provide a foundation for the development of their ability to function competently and confidently in majors' programs. The course will focus on analytical reasoning and thinking to solve real world problems in business, finance, economics, computer science, education and the natural sciences.
Following an introduction to mathematical modeling, different kind of functions will be introduced, Linear, Quadratic, Exponential, and Periodic Functions.
The following example on Linear functions is given; to show how to be approached in a Quantitative Reasoning Course.

Linear Functions (Trip Cost)

Sara and Fatima live in Tariff; they decided to participate in Terry Fox Run to be held on a Friday morning in Abu Dhabi. They need to rent a car for that day, they had two offers from Car Rental companies A and B. Company A offered 15 Dirhams and 1 Dirham for each extra kilometer of travel, Company B offered 40 Dirhams and half Dirham for each extra kilometer of travel.
Which of the two companies cost less, A or B? why? Explain.

Note: Distance between Tariff and Abu Dhabi is 80 kilometers.

One way to work this problem is to give different distances, and to find the cost for each company to see which one is less expensive.

For example suppose we imagine driving only 3 km.

In this case, the cost of company A would be $C_A = 3(1) + 15 = 18$Dhs.
the cost of company B would be $C_B = 3(0.5) + 40 = 41.5$Dhs.
For the travel of 5 kilometers the cost of each company will be as follows:
$C_A = 5(1) + 15 = 20$Dhs.
$C_B = 5(0.5) + 40 = 42.5$Dhs.

We can conclude that the company A would cost less if they are going to drive only a few kilometers.
Now to find out the cost for 80 km (which is the distance from Tariff to Abu Dhabi).
The cost can be worked out differently,
$C_A = 80(1) + 15 = 95$Dhs.
$C_B = 80(0.5) + 40 = 80$Dhs.
You see to travel from Tariff to Abu Dhabi would cost 95Dhs with company A and 80Dhs with company B.
This means that to rent a car for traveling from Tariff to Abu Dhabi, it will cost less to rent from B than from A.
We can describe the cost of each company as a function:
Company A $C_A = 1(d) + 15$
Company B $C_B = 0.5(d) + 40$
One can make tables for each company as follows:

Company A $C_A = 1(d) + 15$

Distance in km (d)	3	5	25	80	100
Cost in Dhs ©	18	20	40	95	115

Company B $C_B = 0.5(d) + 40$

Distance in km (d)	3	5	25	80	100
Cost in Dhs ©	41.5	42.5	52.5	80	90

Their friend Aysha lives in Hamim, half way between Tariff and Abu Dhabi. Which company is less expensive for Aysha to travel with?
Hamim is half way between Tariff and Abu Dhabi (The distance is 80/2 = 40 km).
Now to find out which company cost less for Aysha is:

We can find out either from the graph, or from the equations representing functions, that:
The cost of company A would be $C_A = 40(1) + 15 = 55$Dhs.
The cost of company B would be $C_B = 40(0.5) + 40 = 60$Dhs.
This means for Aysha it will cost less to rent from company A than B.
What would be the distance in order for the two companies charge the same amount?

Use of technology to solve and interpret this example

Maple is one of the software that we can use as a tool for this problem

Linear Functions from Data

	A	B	C	D	E	F
1	*d*	3	5	25	80	100
2	*CB*	18	20	40	95	115

	A	B	C	D	E	F
1	*d*	3	5	25	80	100
2	*CB*	41.5	42.5	52.5	80	90

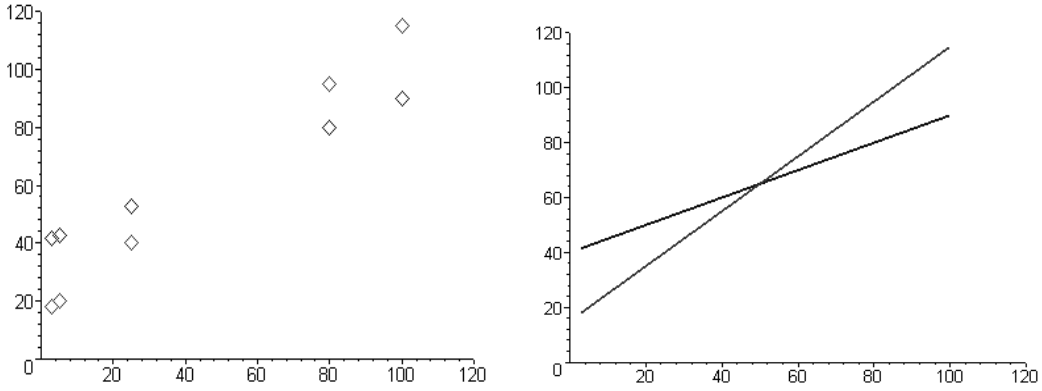
```
> with(plots):
> setoptions(view=[0..120,0..120]):
> data1:=([3,18],[5,20],[25,40],[80,95],[100,115]);
```

data1 := [3, 18], [5, 20], [25, 40], [80, 95], [100, 115]

```
> data2:=([3,41.5],[5,42.5],[25,52.5],[80,80],[100,90]);
```

data2 := [3, 41.5], [5, 42.5], [25, 52.5], [80, 80], [100, 90]

```
> p1:=plot([data1],style=point,colour=red):
> p2:=plot([data2],style=point,colour=blue):
display([p1,p2]);
```

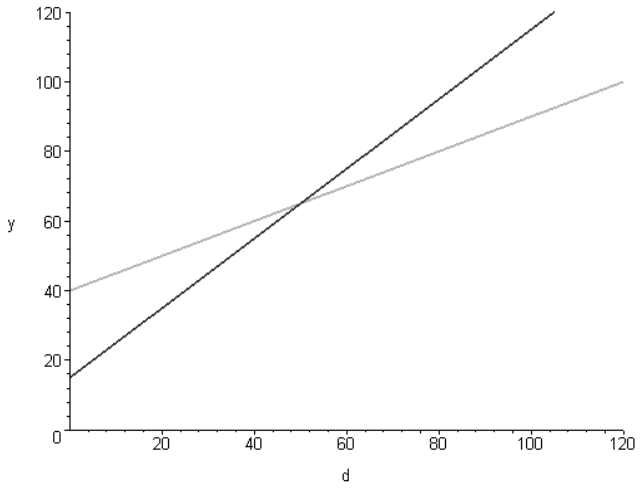


Maple uses the arrow notation to store functions

```
CA:=d->d+15;
> CB:=d->0.5*d+40;
```

Perhaps the most useful way in which one can use Maple is as a graph plotting tool.
Maple can plot graphs in several ways but it's best that to concentrate on the graphing of functions.
The command is : plot(*function,* x-range, y-range, options)
Plotting Multiple Lines and Curves on the Same Axes
The command is plot ([*function1, function2,* ...], x-range, y-range, options)

```
plot({CA(d),CB(d)},d=0..120,y=0..120);
```



Conclusion

Use of basic elements of quantitative reasoning to improve student's level of capabilities in solving and understanding world problems will lead to improve number sense, better student's mental computation, judging results and higher ability in solving problems. As such, with quantitative reasoning it is hoped to provide good bases that make students to be able to build on a better attitude and consequently higher level of confidence in problem solving; to make mathematics a live, easier and more attractive subject.

References

(1) "The Role of Mathematics Courses in the Development of Quantitative Literacy", Deborah Hughes Hallett, Professor of Mathematics at the University of Arizona
(2) Quantitative Reasoning for College Graduates: A Complement to the Standards, by MAA.
(3) Quantitative Reasoning Sequence of Courses Learning Outcomes – Zayed University, 2007.