

# Mathematics Problems via Popular Culture

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**Abstract:** *Creating problems that demonstrate the power and relevance of mathematics has always been a time consuming challenge. Here we demonstrate that the development of such problems can be efficiently aided with the use of video sharing websites, which require students to extract their own data to understand and solve problems based on popular culture.*

## 1. Introduction

Mathematical examples (or quantitative problems) that motivate students to use the various techniques taught in many typical mathematics courses are not easy to develop. Ideally, a good problem will motivate students to see how mathematics can be used to solve a problem and hence help to develop an appreciation of the power of mathematics. A good problem should therefore at least manifestly motivate the use of mathematics as well as allow student to extract relevant and meaningful data to be used in the context of some theory or topic. This would greatly help to clarify to students the relevance of a mathematical topic as well as develop the art of seeing what is needed (and not needed) in order to carry out some required analysis.

There are a number of efficient ways to construct interactive content for use over the web [1, 2] using various practical tools. However, there are very few tools to help with the development of interesting problem sets, or tools to help with the development of problems based on real-life scenarios.

Popular video repositories, such as YouTube [3, 4] and MySpace [5], contain vast amounts of video resources that can be exploited to develop interesting educational resources and assessment sets. Video clips of films, songs and many other forms of popular culture can be readily linked to and used to form the basis of some topic and/or for analysis. The novelty here is that, at first sight, many of the video resources seem to have little to do with learning but, nonetheless, can be exploited to demonstrate the real-world relevance of a topic, as well as be the basis of some formal analysis.

In this paper, we demonstrate how a fully on-line mathematics course exploits video sharing websites to illustrate a number of elementary and important mathematical concepts.

## 2. On-Line Mathematics Course

From January 2007, SIM University students are required to take ten credit units of a university core (130 credit units comprise an ordinary degree and 170 a honours degree). Of these ten credit units, a three-credit unit course is a fully on-line mathematics course “Thinking with Mathematics”.

Thinking with Mathematics reviews a number of important and essential mathematical topics. The course starts with gentle reminders of a number of fundamental principles and reinforces such principles by applying them to solve a variety of problems. The course will be particularly useful to students who have not studied a quantitative subject for some time, and is an ideal reminder of a number of core mathematical skills that students will find useful both in life and in their further studies at UniSIM. Note that students require access to the Internet in order to take the course.

The core of the course is a collection of on-line videos that carefully reviews and reminds students of the following sixteen topics:

1. **Order of Arithmetic Operations:** Upon successful completion of this topic students will understand the correct order of arithmetic operations required for numerical calculations.
2. **Algebra and Equations:** In this topic students are reminded of some standard simplification techniques and the solution of simple equations.
3. **Fractions:** In this topic students will develop an understanding of how to simplify and combine fractions, as well as appreciating the application of fractions for solving problems.
4. **Powers:** In this topic students will be taught to raise various numbers and mathematical expressions to an integer power, and understand what happens to negative numbers when raised to some even or odd power.
5. **Percentage:** In this topic students will develop a firm understanding of the meaning of percentage and be able to apply percentages to solve a variety of problems, as well as using percentages to describe proportions and understand their relationship with fractions.
6. **Ratio and Proportion:** The basic ideas of ratios and proportions are fully discussed and students are exposed to a variety of related problems. Upon successful completion of this topic students will then develop a firm and clear understanding and how to describe and problems related to ratios and proportions.
7. **Averages:** The mean, median and mode of a set of data values are reviewed and applied to various data sets. Upon successful completion of this topic students will develop a firm understanding of the various measure of central tendency and learn to apply them with confidence.
8. **Graphs:** Graphs and charts come in various forms and students are exposed to a variety of ways for expressing information. Upon successful completion of this topic students then develop an appreciation in displaying information in efficient and different but equivalent forms.
9. **Trigonometry:** Students are reminded of the three basic trigonometric functions sine, cosine and tangent, how to evaluate the functions for any angle, and a number of detailed and basic applications are considered.

10. **Area and Volume:** Students are reminded of how to calculate the area of a number of basic areas, such as a square, rectangle, triangle and circle. Upon successful completion of this topic students then develop an understanding of the calculation of more complicated areas in terms of simpler areas.
11. **Patterns:** An important theme within all branches of mathematics is to see number patterns and to generalise. Upon successful completion of this topic students will have developed some basic number pattern skills, which will help to develop their inductive reasoning.
12. **Substitution:** The important process of mathematical substitution is developed here, giving students important skills in using various kinds of formulae. Upon successful completion of this topic students will be comfortable with basic substitution and use a variety of formulas encountered in everyday life.
13. **Scientific Notation:** To develop a basic understanding of science and engineering, students need to master expressing very large and very small numbers in a convenient and efficient way. Upon successful completion of this topic students will have learnt how to express such numbers in a convenient and commonly used way, and also how to combine numbers expressed in scientific notation.
14. **Estimation:** Upon successful completion of this topic students will be in a position to make sensible estimates based on uncertain data
15. **Problems and Review:** A number of more challenging problems are reviewed showing students that such problems can be solved using basic techniques. Upon successful completion of this topic students will then appreciate that many seemingly complicated problems can be solved using basic but important techniques.
16. **Projects:** This topic consists of a collection of open-ended problems based on YouTube videos, which require further research and supported by clear argument.

The sixteen topics are carefully reviewed in great detail starting from very basic ideas and hence no technical prior knowledge is assumed. The multimedia can be used as both an introduction as well as reminders of the various topics.

Following each review video, there are additional detailed videos that consider problems that go beyond the basics, as well as many practice problems where students can practise their understanding and check their answers.

### 3. Course Links

Thinking with Mathematics comes with many detailed video-based worked examples and problem sets. To help show the real world relevance of many topics, it is ideal to have some activities that require students to extract their own data to solve problems.

The well known, and much talked about site YouTube site [3] has a vast and remarkable repository of video resources, which can be exploited to motivate students and to help with the development of interesting real-world examples and problem sets.

Thinking with Mathematics uses a number of such links to YouTube, which students need to study closely in order to extract relevant data and information to solve problems. A number of specific themes, topics and examples include:

- The average speed of cars around a racing track. The video compares an F1 car with other cars, and students need to extract distance travelled and time taken by the various cars to complete a lap [6]. The video can be used to discuss in detail the meaning of average speed since the cars slow and speed up at various parts of the track, as well to discuss the actual distance travelled by the cars since the non-F1 cars tend to take much wider turns on bends etc.
- The average of a set of numbers: A simple and interesting example is a link to a set of numbers discussed and debated in the American TV series “LOST”: LOST Hurly and his numbers [7].
- Checking quantitative statements made by popular songs [8, 9]. There are a number of popular songs that make various quantitative statements from distance travelled by a spaceship, to the number of soldiers killed during the Vietnam war and the unemployment rate in the UK.
- Time and motion analysis [10]. This particular video is of a man making a well-known Indian dish and the student is asked to calculate, based on the observed rate, how many such dishes the man can be expected to make over various time intervals.
- Distance travelled, as provided by a plane flying over central London [11]. Given the average approach landing speed of a Boeing 747, based on the time-line of the video, students are asked to estimate the distance of Central London from Heathrow airport.
- Checking the real-world possibility of film scenes [12]. Here students are required to perform some extended investigation regarding film scenes and use mathematics to check on the validity of a scene. As a particular example, from the film *Apocalypse Now*, students are asked to investigate if it is possible to hear attack helicopters over the noise of the sea a few minutes before the helicopters arrive. From the film clip, students know the time delay between the victims first hearing a helicopter to arrive and hence can determine how far the helicopters were away when they were first heard etc. Such film-scene-checking is ideal for extended studies or projects. Here it is worth noting that an answer may not be known and students can be asked to provide an argument to confirm or not the real-world possibility of a film scene or any other interesting media clip.

#### **4. Stability of Hyperlinks**

There are some obvious concerns with regard to relying on external repositories; the most obvious is the removal of videos. However, experience has shown that most removals are quickly restored!

A much more worrying prospect is that hyperlinks may soon require permission. A Texas judge [13] has recently made a ruling that linking to a Web page violates copyright. Declan McCullagh News.Com reports that SFX Motor Sports has won a case against Robert Davis, the operator of Supercrosslive.com, a Web site, which linked directly to audio files for motorcycle races on SFX's Web site.

Web sites often link to other sites, no permission is required and no laws are infringed. However, a 2000 case confirmed the legality of "deep linking" into any page of a Web. This is worrying since if you take away the ability to link then you have taken away the fundamentals and full potential that makes the Web work.

SFX claimed that Supercrosslive.com's direct links to audio files on its website threatened its business, because listeners could bypass the advertisements on SFX's website. It is argued, however, that if SFX intended to prevent people from going directly to audio files, a small change in its website server configuration could have stopped them from doing so.

Clearly, if files had been copied and reposted then SFX would have an open-and-shut copyright case, but many don't agree where the copyright law applies in this particular case.

The judge's decision is currently under appeal with the large web players such as Google and Yahoo watching the case closely as the final outcome of the case will effect how the web can be used. With regard to educational repositories, or sites that can be exploited as such, the outcome will have serious legal consequences and the use of hyperlinks will need to be used with greater care. Copyright issues also may vary from country to country!

## **5. Conclusion**

It has been shown that a fully on-line mathematics course can exploit popular video sharing repositories to create interesting learning resources that help to show the real-world relevance of a mathematical topic. The problems can not only be fun but also require students to extract relevant information or data to solve problems without much additional effort needed by the instructor or course developer.

The examples mentioned exploit YouTube video clips, which are part of popular culture and hence help to show the real-world relevance of a topic. For example the link to the YouTube video [6] requires students to extract both distance travelled and time intervals of three cars and compare their average speed. The video is fun to watch, and in some sense is better than actually being at the race track since the video gives an all round view of the race, which is not possible if you were actually located at the race track!

The examples demonstrate that a ready source of problem sets can be developed which take students outside the comfortable world of model answers and well-defined closed problems. Students can be placed into situations where they need to extract their own relevant data or information and process the information to form a conclusion, and at the same time making the problem at hand relevant and hopefully fun and motivating.

An interesting variation of the approaches discussed here can be found in [14], where various film clips are examined and investigated to see if they comply with the laws of physics!

References to popular culture and the use of popular video repositories can help to motivate students to learn what they may have previously perceived as being a remote uninteresting topic. Links to video clips based on popular culture help to bring topics alive and manifestly demonstrates the real-world relevance of mathematics in all walks of life, as well as empowering individuals with the tools and techniques to distinguish between reality and fantasy.

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