The study of three universal constants in science education

Wei-Ling Liu

Chienkuo Technology University
Changhua, Taiwan

ABSTRACT: There are many kinds of science education software. However, one rarely finds software for research on the three universal constants; π (ratio of the circumference of a circle to its diameter), *e* (natural exponential) and c (velocity of light). The author of this article has focused on π, *e* and *c*. Learning about π, *e* and *c* can be very boring. This paper describes 48 hours of auxiliary text suitable for a general education course. Second, 36 units of information about π, *e* and *c* have been collected. This included material from ancient legends, geometry, algebra and by computer analysis. Third, a Web site was developed using 2D flash to display information about π, *e* and *c*. This can be used to teach the characteristics of π and *e*, and could also become part of the general education curriculum in Taiwanese colleges.

INTRODUCTION

Computer applications in mathematics education are dealt with in this article. They developed from an education research project, which considered three universal constants: π (ratio of the circumference of a circle to its diameter), *e* (natural exponential) and *c* (velocity of light) [1-3]. There is considerable relevant, published research data. However, for students, the information seems inadequate. The main reason for this is that the material is too academic and requires basic mathematics knowledge. Hence, the author has developed a computerised tool suitable for science and mathematics education.

A teaching programme for a single-semester 36-hours course was designed for students in general education at university. In this article, the author first introduces the course content design for π, *e* and *c*. This includes teaching objects; the teaching method; teaching material and a computer-aided teaching application developed using 2D [4].

The system was built and verified. Some suggestions for further research are provided. In this article, the next section introduces the course design. The following section describes the research steps, including the structure of the study and the development of the Web site. In the latter section, the advantages are considered and suggestions put forward for further research.

The π, *e* and *c* course content the covered the following:

- *The teaching object*: The main object of this course is to facilitate science education built around π, *e* and *c*; such that the knowledge is transferable to physics.
- *Teaching method*: In the teaching method of π, *e* and *c*, the 2D animation demonstration by the teacher and discussion between the teacher and students occur at the same time.
- *Teaching material*: Total class time is 48 hours (one semester).

BRIEF HISTORY OF π, *e* AND *c*

The history of π, *e* and *c* can be roughly divided into several sections, as follows [5-9].

2D Flash Teaching Material for π, *e* and *c*

The findings of this study are displayed by means of the Web site homepage, developed through the following procedure [10-12]:

- First step: collect the essential mathematical information on π, *e* and *c*.
- Second step: 12 teaching units for each of π, *e* and *c* were developed.
- Third step: 36 units were computerised.
- Fourth step: the Web site homepage was developed with 2D Flash (Super Link).

Software and hardware requirements are as follows:

- Windows XP or upgrade version.
- Screen resolution set to at least 1024×768.
- Acrobat Reader 8.0 or upgrade version.
- CPU: Intel Pentium3 1 GHz / (same grade).
- RAM: At least 512 M; 4 times CD ROM or/ DVD.

Table 1: The history of π.

Year	The value of π	Source	Year	The value of π	Source
2000 B.C.	$\pi = 3\frac{1}{8}$	Babylonian	650 A.D.	$\pi = \sqrt{10} = 3.16$	Brahmagupta: Indian
2000 B.C.	$\pi = 3.1605$	Egyptian	1220 A.D.	$\pi = 3.141818$	Fibonacci: Italian
1000 B.C.	$\pi = 3\frac{1}{8}$	Chinese	1761 A.D.	π is an irrational number	Johann Heinrich Lambert:Swiss
300 B.C.	$3.141587 < \pi < 3.141602$	Archimedes: Greek	1775 A.D.	$e^{i\pi} = -1$	Leonhard Paul Euler: Swiss
263 A.D.	$\pi = \frac{157}{50} = 3.14$	Liu Hui: Chinese	1794 A.D.	π and π^2 are irrational number	Adrien-Marie Legendre: French
450 A.D.	$3.1415926 < \pi < 3.14159272$	Chong-Chih Tsu: Chinese	1873 A.D.	π is transcendental number	Charles Hermite: French
530 A.D.	$\pi = 3.1416$	Aryabhata: Indian	1882 A.D.	π is transcendental number	Ferdinand von Lindermann: German

Table 2: The value of *e* with various representations.

$e = \lim_{n\to 0}(1+n)^{\frac{1}{n}}$	$e = 1+\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+\cdots = \sum_{n=0}^{\infty}\frac{1}{n!}$		$e = \frac{878}{323} = 2.718266254\cdots$
$e^{\pi} = 23.14069263\cdots$	$\pi^e = 22.45915772\cdots$	$\ln(-1) = \ln(e^{i\pi+2n\pi}) = i\pi + 2n\pi,\ n = 0,\pm1,\pm2,\cdots$	
$i^i = e^{\frac{\pi}{2}} = 0.207879576\cdots$	Eular (Swiss): e is an irrational number	$e = 2+\cfrac{1}{1+\cfrac{1}{2+\cfrac{2}{3+\cfrac{3}{4+\cfrac{4}{5+\cdots}}}}}$	Charles Hermite (French): e is a transcendental number

Table 3: The value of *c*.

1	Basic definition
2	The light velocity in special relativity: A.D. 1905
3	Light speed measure-Tradition method: A.D. 1629 and A.D. 1638
4	Moons of Jupiter: A.D. 1676
5	Aberration of light: A.D. 1728
6	Toothed wheel EM constants: A.D. 1849, A.D. 1862
7	Rotating mirror: A.D. 1926
8	Cavity resonator: A.D. 1950
9	Radio interferometry: A.D. 1955; Laser interferometry: A.D. 1972, A.D. 1974, A.D. 1980
10	Special relativity: A.D. 1905
11	Application of general relativity-1- Gravitation lens: A.D. 1919
12	Application of general relativity-1-Red shift: A.D. 1919

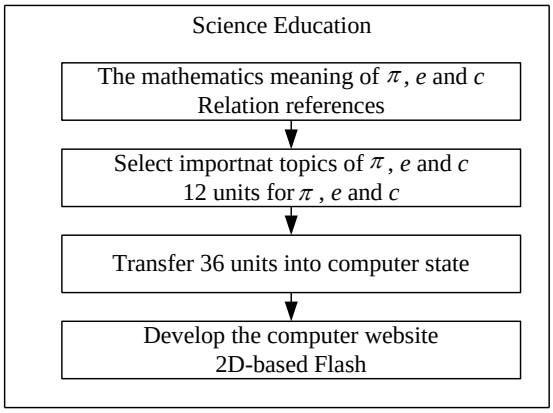

Figure 1: The structure of the research.

The main functions of the Web site are shown in the following Figures (form Figure 2 to Figure 31).

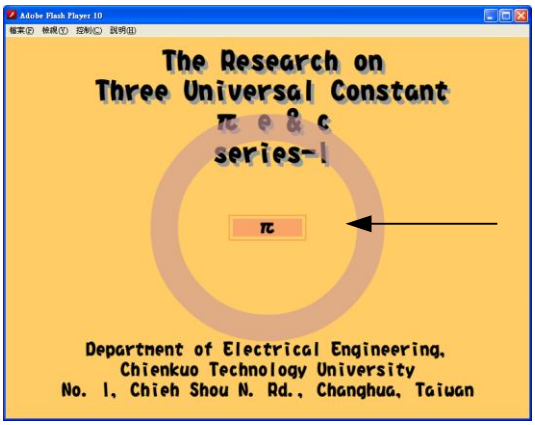

Figure 2: Main screen for π.

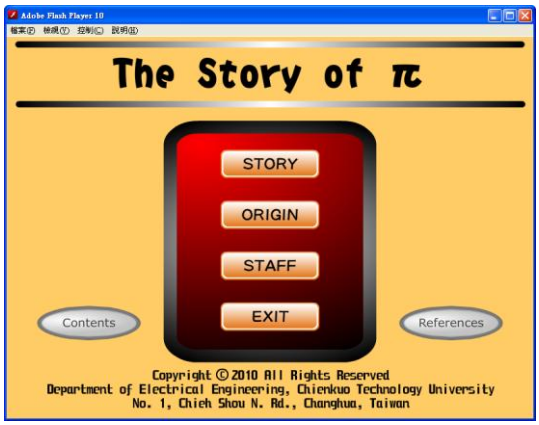

Figure 3: Main menu for π.

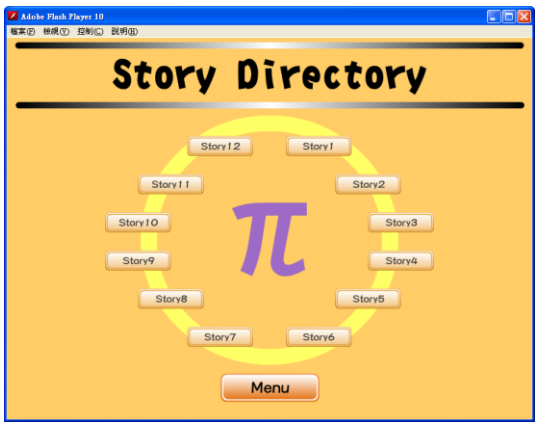

Figure 4: The directory of 「STORY」

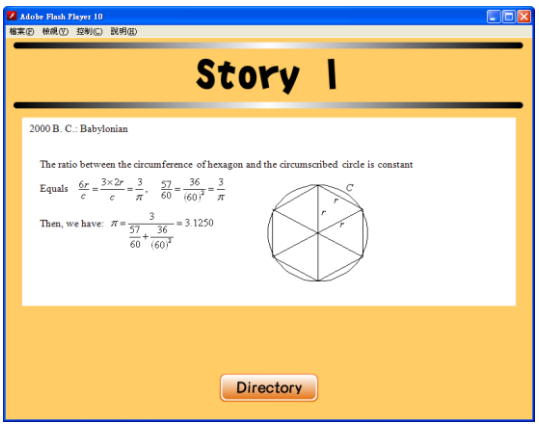

Figure 5: The contents of story 1 (example).

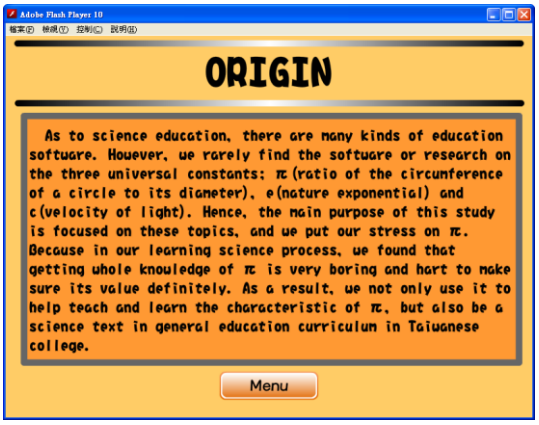

Figure 6: The contents of「ORIGIN」

Figure 7: The Contents of「STAFF」

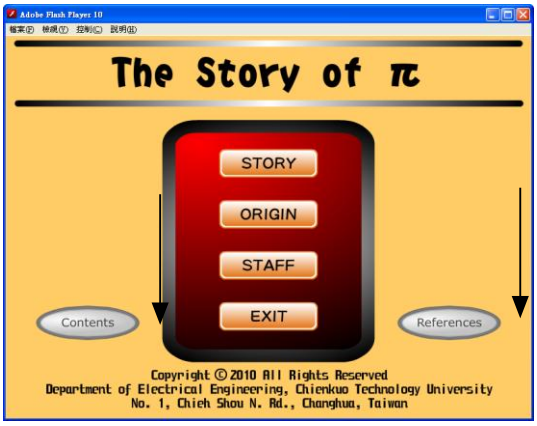

Figure 8: The「Contents」and「References」icons.

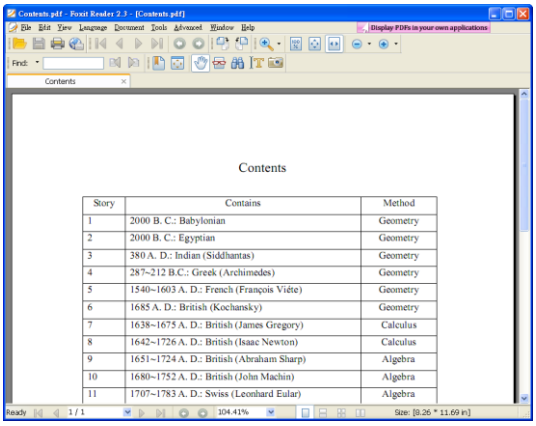

Figure 9: The contents of「Contents」

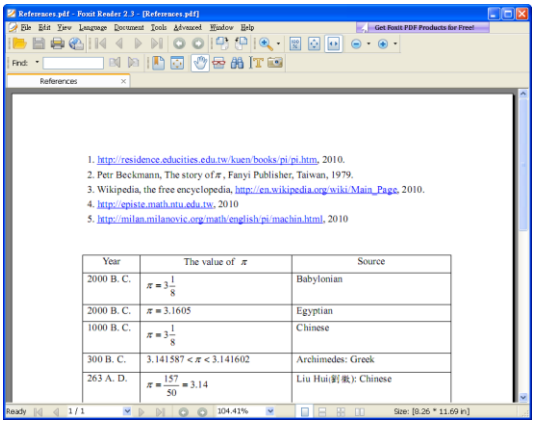

Figure 10: The contents of「Reference」

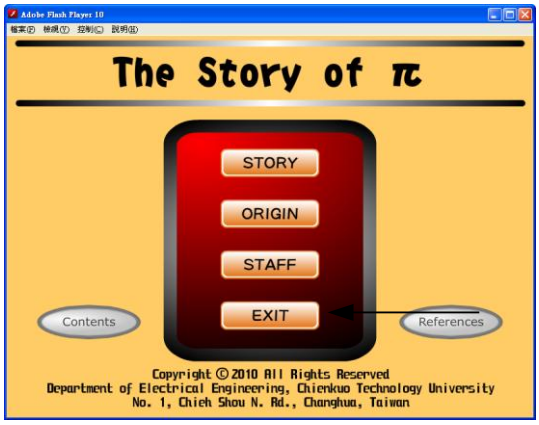

Figure 11: The「EXIT」icon.

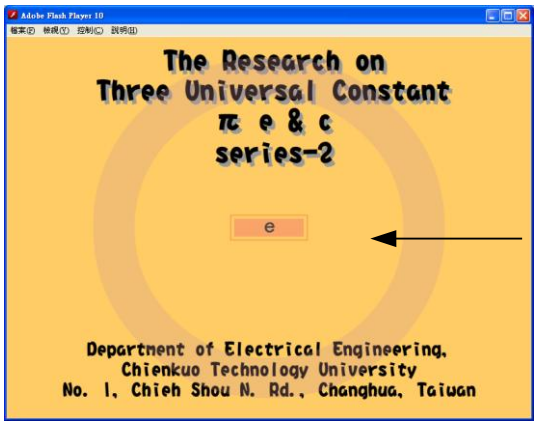

Figure 12: Main screen for *e*.

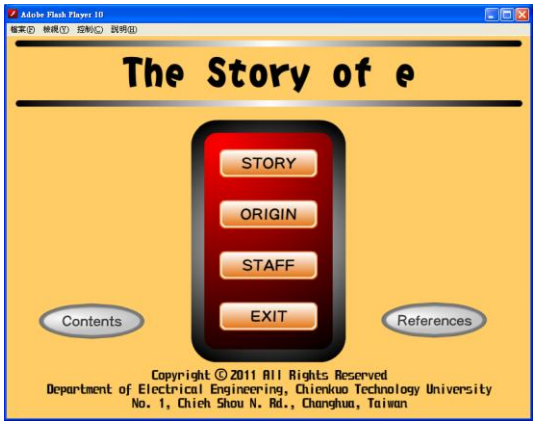

Figure 13: Main menu for *e*.

Figure 14: The directory of 「STORY」

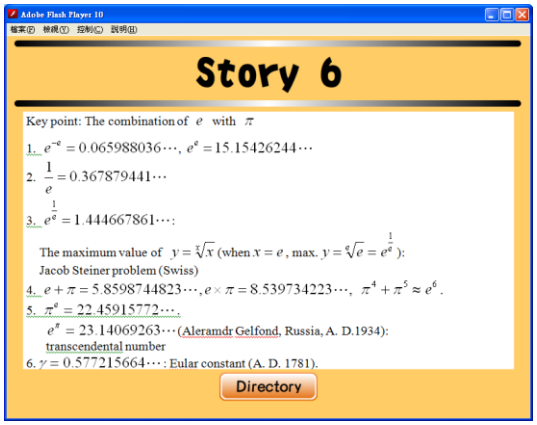

Figure 15: The contents of story 6 (example).

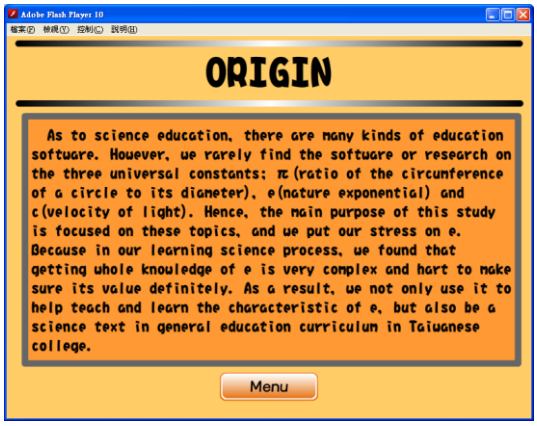

Figure 16: The contents of「ORIGIN」

Figure 17: The Contents of「STAFF」

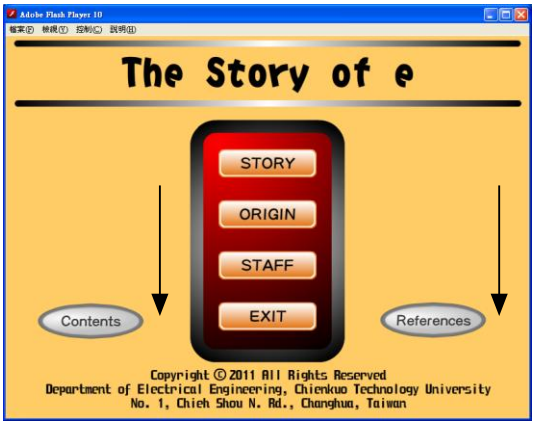

Figure 18: The「Contents」and 「References」icons.

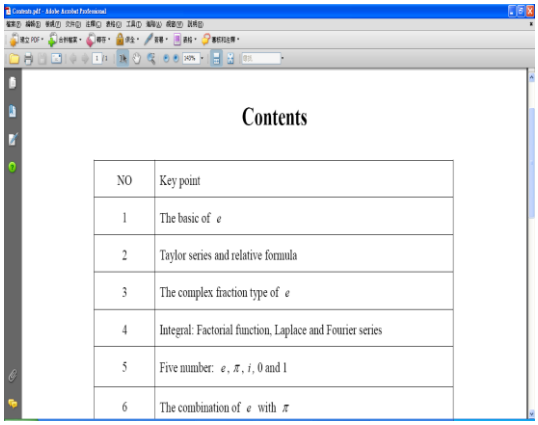

Figure 19: The contents of「Contents」

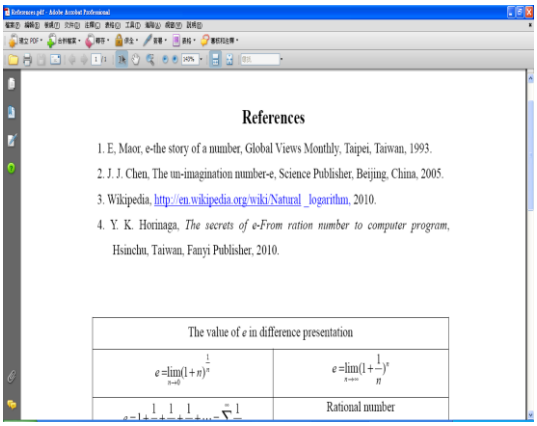

Figure 20: The contents of「Reference」

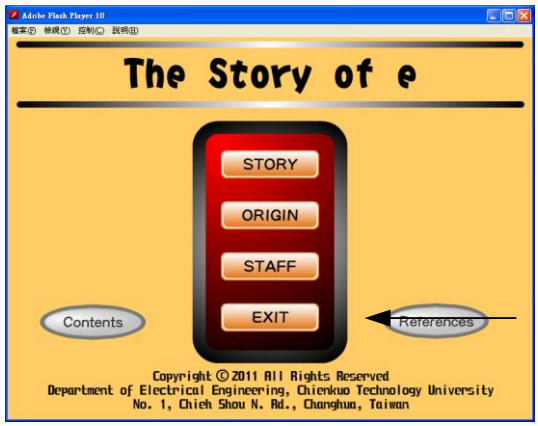

Figure 21: The「EXIT」icon.

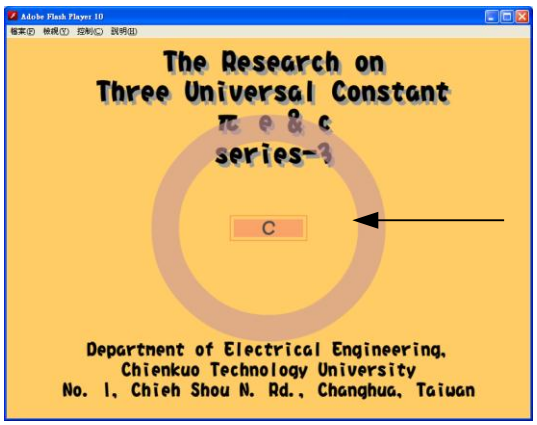

Figure 22: Main screen for *c*.

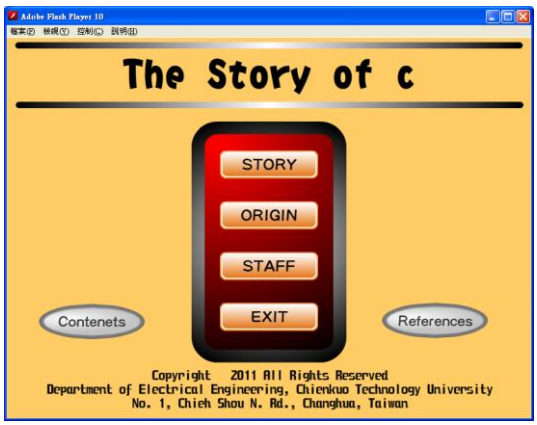

Figure 23: Main menu for *c*.

Figure 24: The directory of 「STORY」

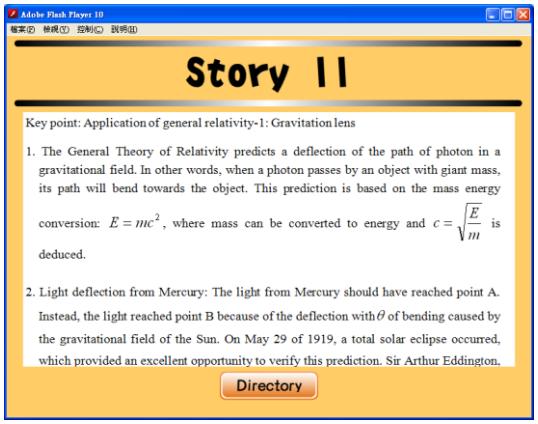

Figure 25: The contents of story 11 (example).

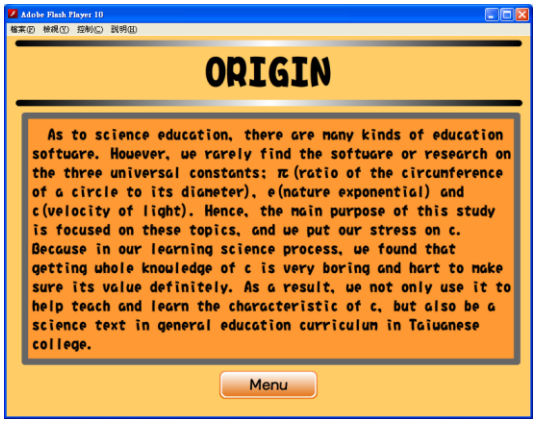

Figure 26: The contents of「ORIGIN」

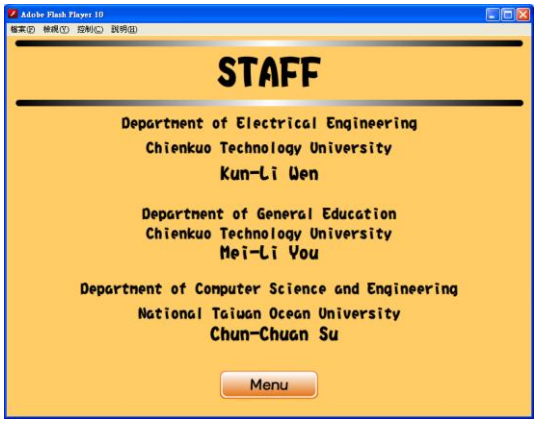

Figure 27: The Contents of「STAFF」

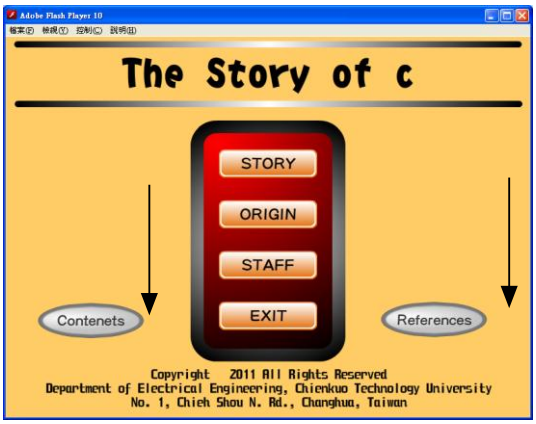

Figure 28: The「Contents」and 「References」icons.

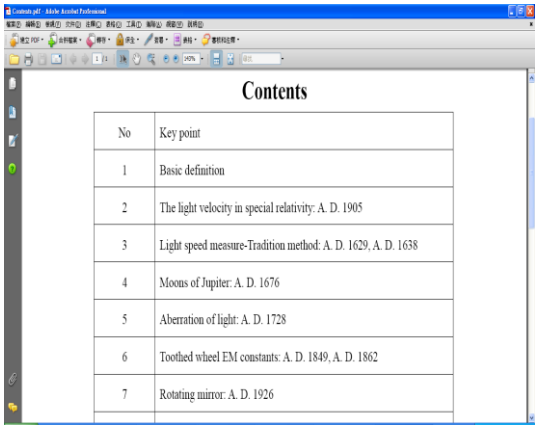

Figure 29: The contents of「Contents」

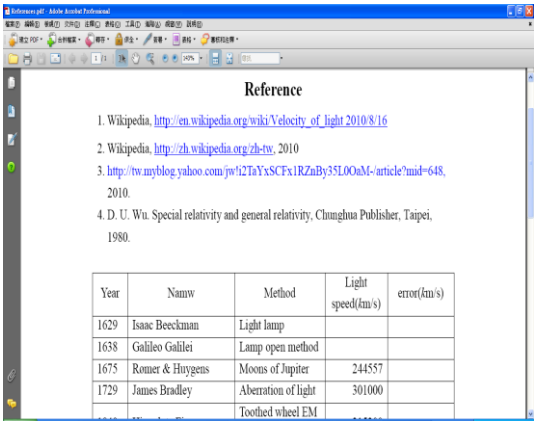

Figure 30: The contents of「Reference」

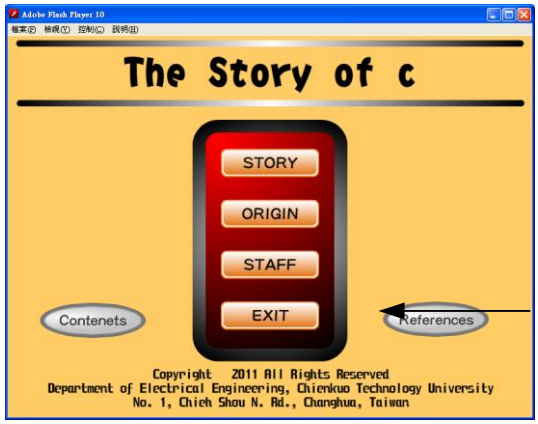

Figure 31: The「EXIT」icon.

CONCLUSIONS

In this research, a science education course was developed to be precise and teachable in class. It was designed to make students more confident and appreciative of science education. Hence, this study to enhance the understanding of π, *e* and *c* in science. The results were displayed by means of a Web site homepage, which included the essential information about π, *e* and *c*.

Mathematics is very important in engineering. The author of this study has integrated engineering and science, and provided a new approach to science education.

The results are:

- The basic concepts and information on π, *e* and *c* data were developed in this study, and these were used to develop effective teaching of π, *e* and *c*.
- Promotion of science education combined with the mathematics of π, *e* and *c* suitable for education at freshman level.
- Familiarity through the operation of computerised systems.

In summary, the combination of engineering and science shows a new integrated type of science education. The research could be extended to include vocal systems.

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