

A Report on the Feasibility of Mobile Devices for Mathematics Learning in Higher Education

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Overview

This report presents an investigation into the educational potential of mobile devices in supporting mathematics teaching and learning.

Aims

The aims of these feasibility studies are to identify and test some features and functionalities which may be of use for teaching and learning mathematics, both formally and informally; as well as for mathematics support. The results of the studies will be used for the selection of mobile device(s) for my PhD studies, which are focused on the integration of computer games and mobile technologies into teaching and learning mathematics in higher education.

The Mobile Devices Examined

Most of the mobile devices that the SIGMA CETL owns have been carefully examined. These examined mobile devices are Samsung Q1, Sony UX PC, Personal Digital Assistant (PDA or HP iPQA hx2100), Sony PlayStation Portable (PSP, model 1003), Video iPod, Nokia N95 mobile phone, Prada mobile phone and Nintendo DS.

The Rationale of the Selection of Maths Websites

In support of my PhD studies the emphasis was on testing the features that could be used for game-based learning, online learning and mobile learning.

Based on my earlier substantial literature review, I had some mathematics learning resources in mind, such as the “MathTutor” (both the online version and videos), online gaming “MyMaths”, the BBC’s Bitesize GCSE revision, Mathsnet and Math4mobile. Their characteristics are follows:

- MathTutor website contains a large collection of videos for maths learning, diagnostic tests and exercises. The video presenters are experienced maths educators, one of them was previously a TV education presenter. The contents are of up to A-level maths standard.

- MyMath website is devoted to students of 11-16 years. It contains many mathematical games, which are well-designed. The author has already visited a summer school in Yorkshire to see how students were attracted to this website and enjoyed playing the games for 5 hours that day.
- BBC's bitesize for GCSE revision includes some maths games and mobile games. This website has been widely used in UK schools.
- Mathsnet website also has a large collection of computer maths games and mock exam tests; the maths level is up to A-level standard.
- Math4mobile website has 5 free downloadable maths games for Java enabled mobile phones.

One of the foci of this feasibility studies is to look at whether or not the mobile devices examined can be used for making use of the above maths learning resources, including online mathematical computer games.

The Presentation of the Report

In these feasibility studies, approximately 100 tests were carried out on the 8 mobile devices and many photographs were taken to record the testing process and the results.

This report will describe the basic functions of mobile devices, operational issues, useful features, strengths and weaknesses and suggestions for each mobile. It also presents how a device copes with each selected mathematics learning resource in the selected websites.

The investigation into each mobile device will be described in a separate chapter and a summary will be given at the end of each, followed by some images showing the testing results.

In the conclusions chapter, apart from a descriptive text which reflects the author's thoughts and analysis, a table will be presented for a summary of useful findings on technical issues (See Appendix 9). The other appendixes will give summaries of findings on how each mobile device fared in the tests. Finally, some recommendations will be given.

Chapter 1. The Samsung Q1

Introduction

The Samsung Q1 is a small and strong UMPC (Ultra Mobile PC) with an Intel Celeron M ULV processor, 256MB (up to 1GB possible) DDR2 memory and with a 20~60 GB high capacity hard disk drive. It has a 7" touch screen with a basic resolution of 800*480 pixels. With an external display connected, it has maximum resolution of 2048*1536. It is managed by the Microsoft Windows XP Tablet PC Edition, with powerful multimedia functions and multiple network support, including wired LAN, wireless LAN and Bluetooth (optional). Its weight is only 779g (excluding the Bluetooth modules). It is a portable and yet fully functional PC.

Useful Features for Maths Learning

- Using the Microsoft Multimedia Player to play maths video games of various formats that might possibly not run on a PDA, PSP or a smart phone.
- Using PowerPoint slides to foster maths learning.
- Browsing websites with maths learning material and playing online games.
- Communications via email
- USB and Bluetooth technology enabled data transfer between different devices.

The Results of Testing for Maths learning:

1. Testing the display of a pdf file

The quality of the display of Word documents and pdf files is very good; the characters are very clear and graphs and pictures are shown in rich colours.

2. Testing the Internet connection

The Internet connection via Coventry University wireless network is functional and stable. Browsing webpage caused no problems.

3. Testing online gaming at www.mymaths.co.uk.

This website can be fully viewed. All games can be played. The graphs, characters, and images are very good (See Figure 1 and Figure 2). The quality of the display is very good, however, the website was not designed for this smaller screen, and hence some small characters (normally instructions on the menu) are too small to see. The access to the sub-webpage and hyperlinks is fine.

4. Testing Mathtutor videos at www.mathtutor.ac.uk.

The display of Mathtutor videos is excellent. The graphics and hand-writing are very clear (See Figure 3 and Figure 4).

5. Testing the access to web-based maths learning resources at www.mathsnet.net.

This website can be fully viewed, too. There are online interactive maths exercises and exam papers at A-level: The graphics are very clear (See Figure 5). Web pages can be downloaded and displayed. Characters are very clear too. There is also a link to another useful website for A level maths e-learning (www.livemaths.co.uk), in which there is a video A level maths tutor using web-based lessons; subscription is required for their use.

6. A collection of mathematical games called “Phoenix Quest” at www.cs.ubc.ca/labs/egems/

This website can be fully downloaded and displayed. The quality of display, including colour, characters and images is very good (See Figure 6).

7. Testing online maths games at BBC website: bitesize for GCSE revision.

The display of graphics and characters is very good.

8. Testing an online maths game entitled “Phoenix Quest”

The game is playable and the colours are very rich (See Figure 7).

9. Playing an online mathematical game called Dimenxian at www.dimenxian.com.

The visibility is good but the display area is only half the height of the window; tool bars have occupied the rest. It cannot show the whole pop-up window unless the resolution of the screen is changed. The auto scaling function supports 3-step resolutions (800*480 by default -> 800*600 -> 1024*600).

10. Testing maths games at www.math4mobile.com.

The visibility is good but sometimes the whole pop-up window cannot be displayed.

11. Testing www.google.com, search for “wave equation”.

The contents are clearly displayed. The colours of the image are very rich (See Figure 8).

12. Testing the use of Bluetooth technology

Files were successfully transferred to a PRADA mobile phone via Bluetooth technology.

13. USB

The USB connection is functional.

14. Testing Emailing function

There is no problem in sending or receiving emails, including attachments.

Summary

The Samsung Q1 PC has most of the functionality available in a desktop PC, it can therefore perform similar tasks. The most useful features include playing video games or online games in different formats, viewing PowerPoint slides and accessing the Internet both wired or wireless.

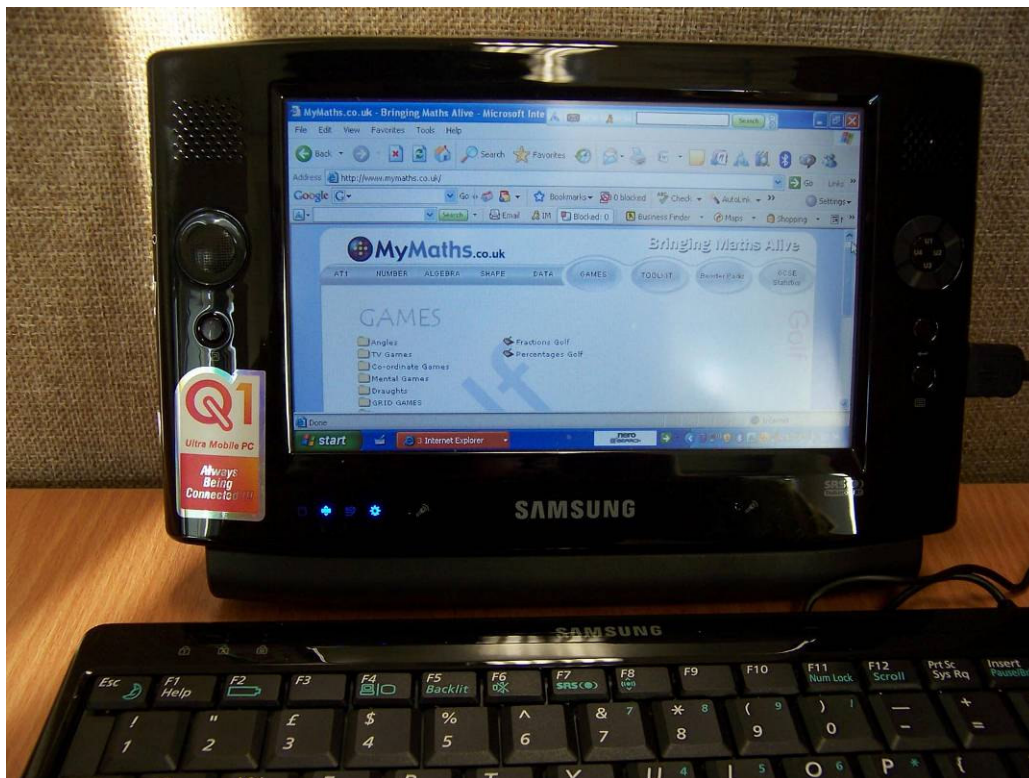


Figure 1 MyMaths website on the Sumsung Q1. The characters are clearly displayed.

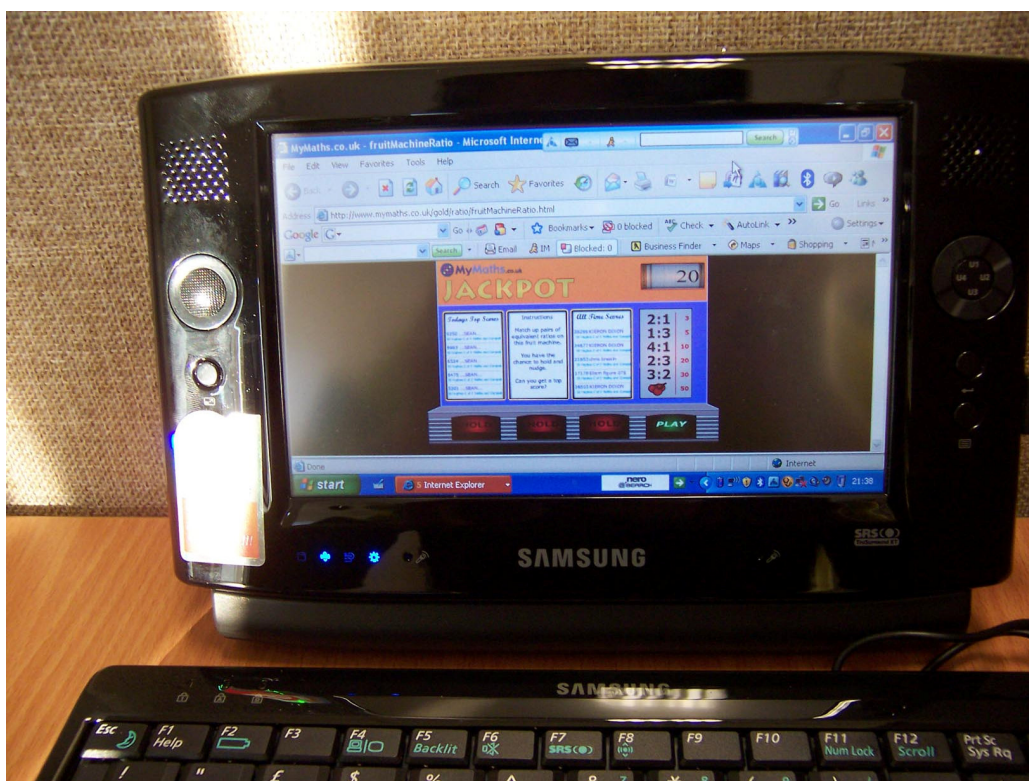


Figure 2 One of the computer games from the MyMaths website on the Samsung Q1.

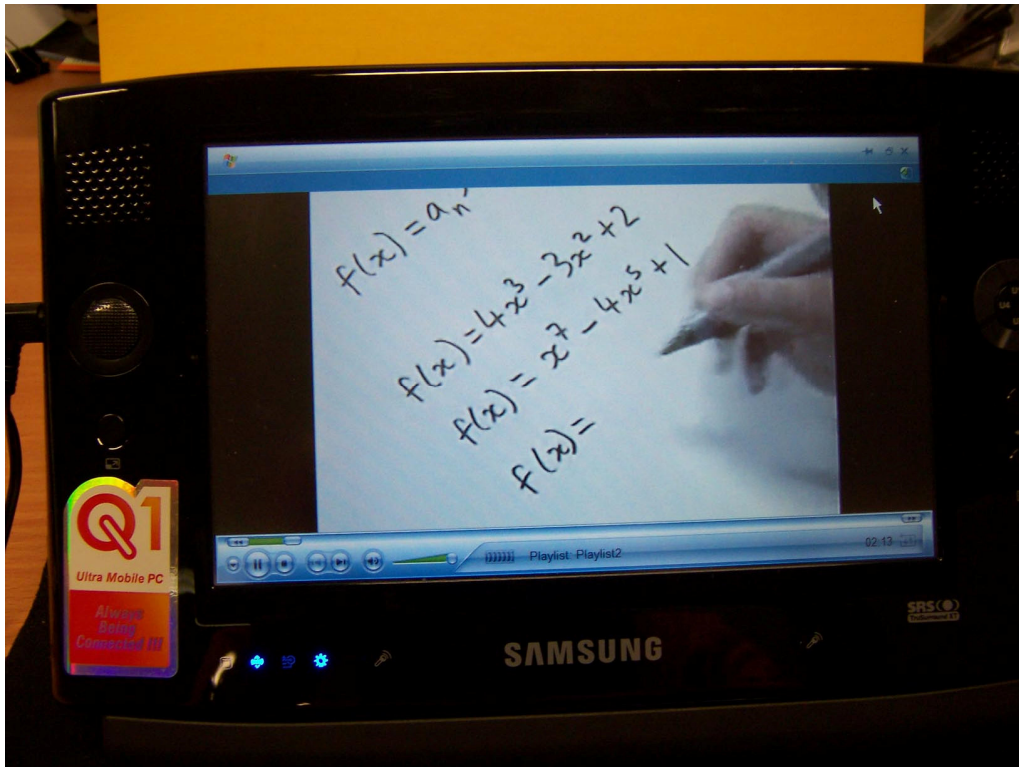


Figure 3 An online video from the Mathtutor website shows hand-writing clearly on the Samsung Q1.

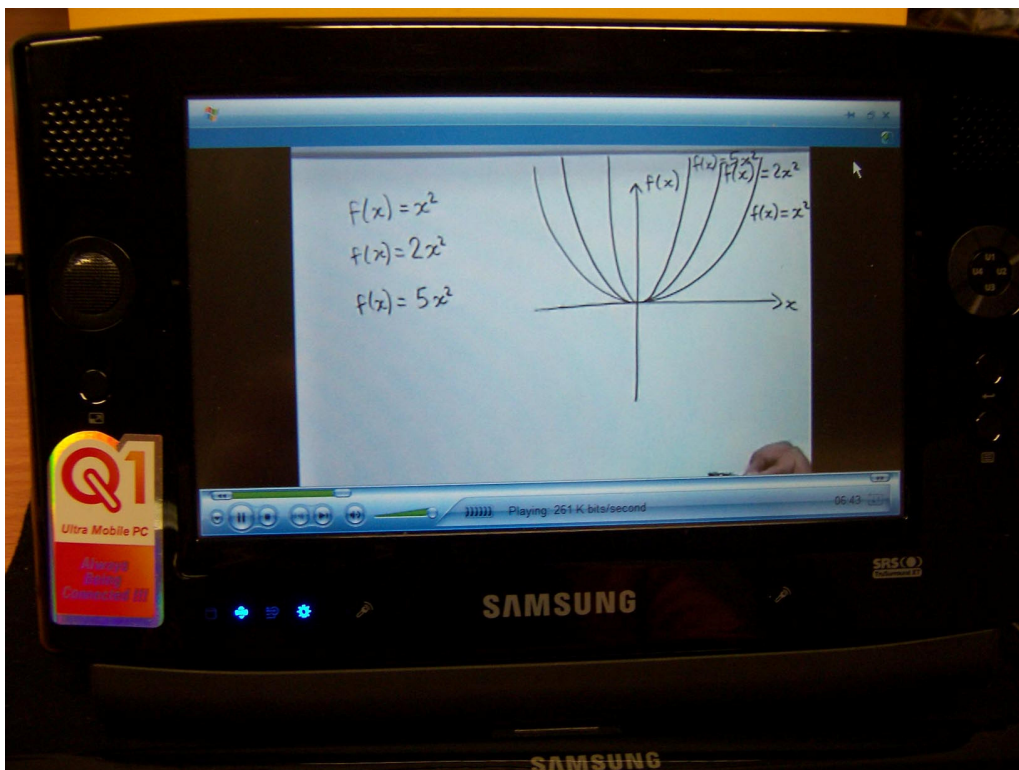


Figure 4 An online video from the Mathtutor website shows good quality graphics on the Samsung Q1.

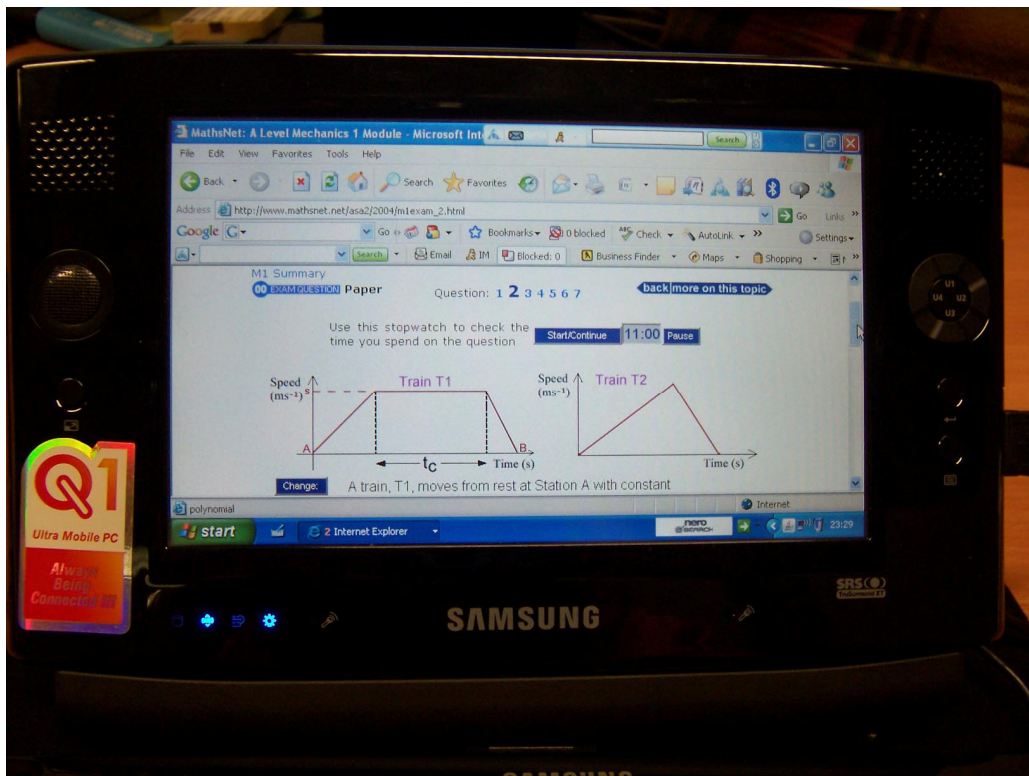


Figure 5 A maths exam paper on the Mathsnet website displayed on the Samsung Q1.

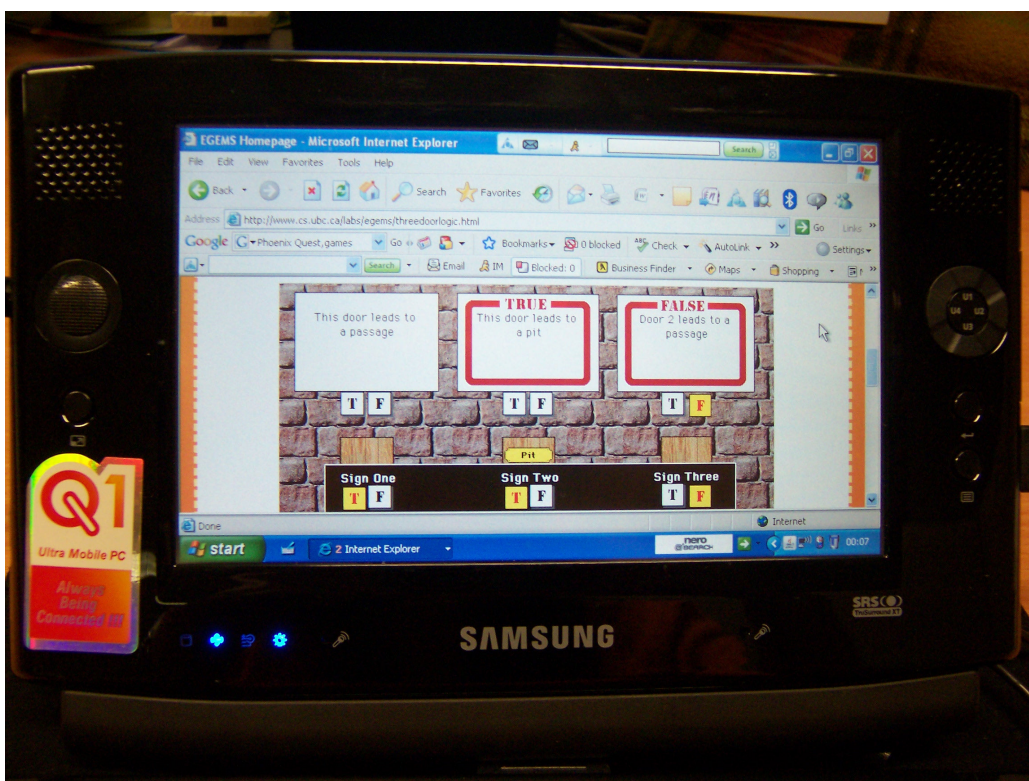


Figure 6 A computer game called "Phoenix Quest" playing on the Samsung Q1.

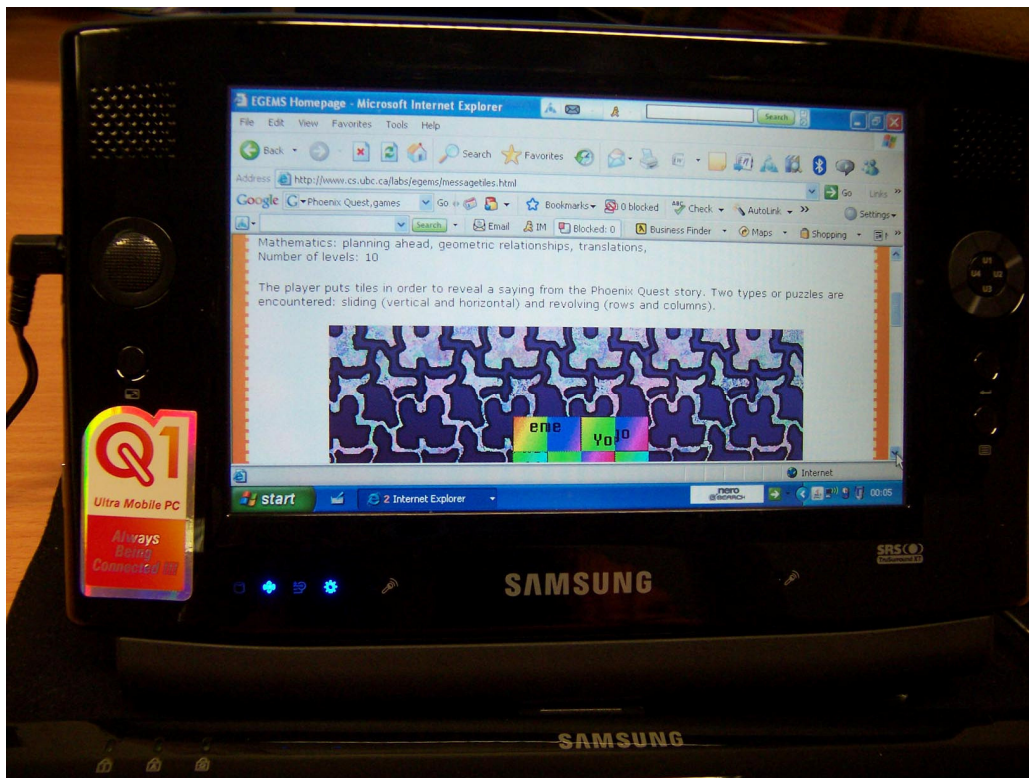


Figure 7 A computer game called “Phoenix Quest” displays rich colours on the Samsung Q1.

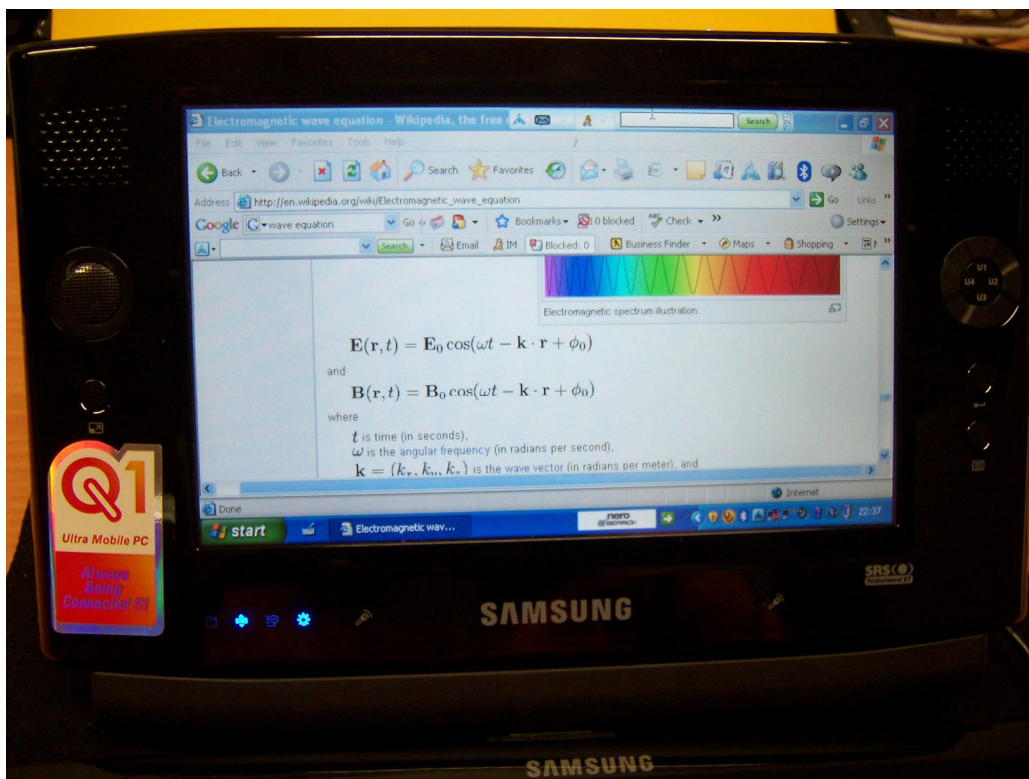


Figure 8 A Google search for “wave equation”, in which a wide spectrum of colours and Greek letters in the equations are displayed.

Chapter 2. The Sony UX PC (Ultra Mobile PC)

Introduction:

The Sony UX PC is a light-weight fully functional computer, which runs Windows Vista™ Business system, with 1024 MB memory (RAM), using Intel® Core™ Solo CPU, at 1.33 GHz. It can be connected to the Internet by wireless LAN, and has Bluetooth functions. It has two cameras. There is a USB slot and a slot for a Memory Stick Duo/PRO Duo media card.

Like a standard PC, it can run Microsoft applications such as the MS Works word processor. It also has a Caps Lock key for typing letters in uppercase. However, subscript cannot be used, making it unsuitable for writing some equations.

Useful Features for Learning:

- Access to the Internet
- Playing Video games
- Running Microsoft applications (e.g. Word Processing, Excel, PowerPoint)
- USB feature
- Supports Bluetooth technology
- Emailing

The Results of Testing for Learning:

1. Testing the display of www.math4mobile.com

The website works well (See Figure 9). 5 maths games written in Java can be downloaded to Java enabled mobile phones free of charge.

2. Testing the display of www.mathsnet.net

This website contains maths learning resources up to A-level. It can be downloaded and displayed but the characters are quite small. Graphics are very clear (See Figure 10).

There are many games within the website; however the games take a long time to download.

3. Testing the display of www.mathsnet.com

An online game called “Queen v Knight” can be played (See Figure 11), although the downloading is very slow.

4. Testing the display of www.mymaths.co.uk

It works very well but some characters in the menu of a game or for game playing instructions are very small. Figure 12 shows a computer game called “Golf”.

5. Testing the display of BBC Bitesize for GCSE Revision

The device handles these resources well. Maths games can be played and the images and graphics are very clear (See Figure 13). Sounds are fine.

6. Testing the display of www.mathstutor.ac.uk

Downloading is slow. The video tutorial cannot be downloaded and diagnostic tests and exercises cannot be displayed. There is difficulty with “View online”, which may be due to the limitation of memory.

7. Using www.google.com

The search engine is functional and the display is very good (See Figure 14).

Summary

The UX PC is a fully functional PC, although being much smaller and lighter it is very portable.

It can easily be connected to the Internet wirelessly, and so it is possible to use it for mobile learning. However, the memory is often not enough for downloading large websites, especially those linked to a database. Downloading can be slow, but some websites and online maths games can be downloaded and viewed or played.

The display of characters is not always satisfactory; in particular, they are sometimes too small in a game playing menu or its instructions.

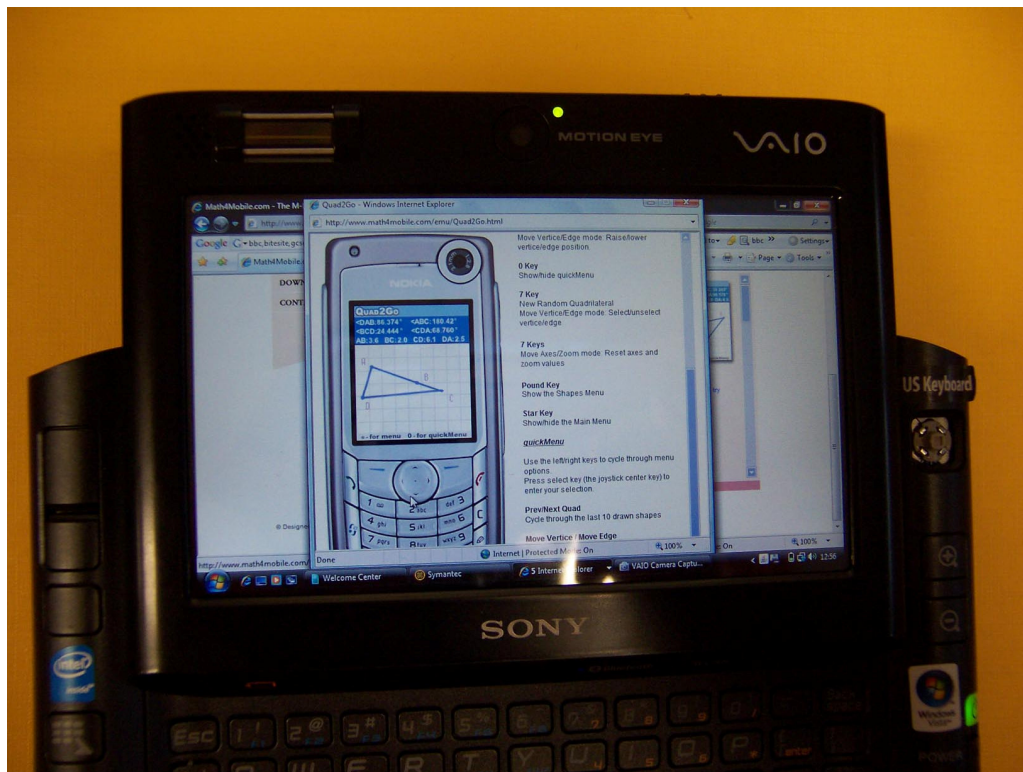


Figure 9 A webpage from the math4mobile website shows clear graphics on the UX PC.

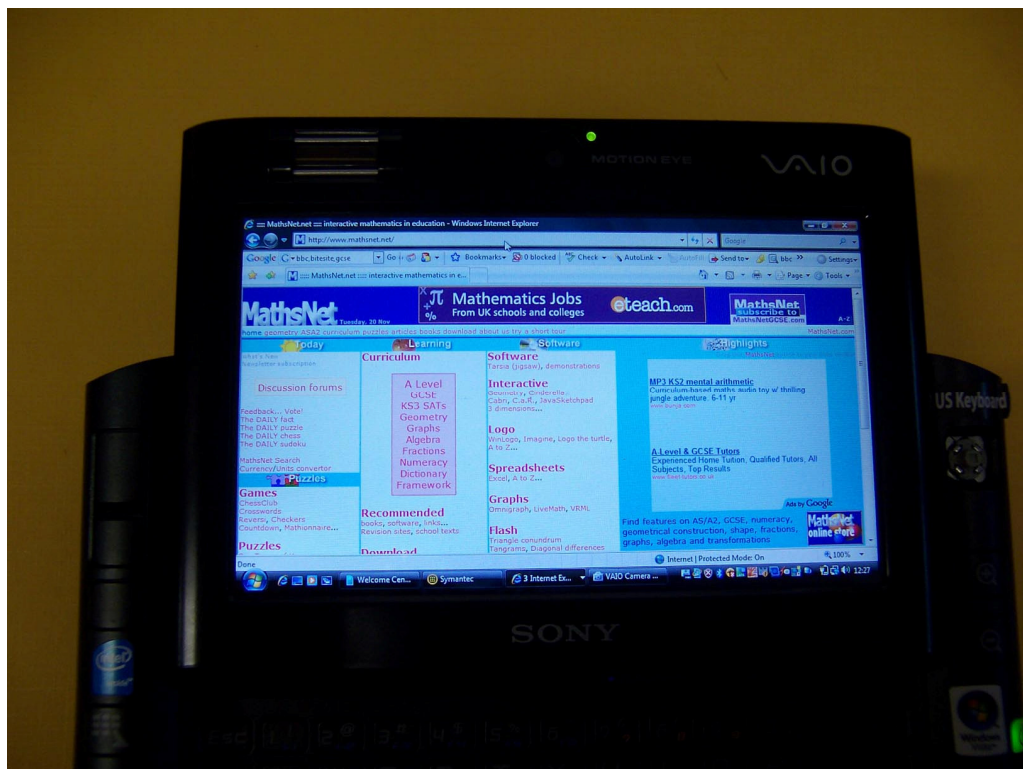


Figure 10 On the Mathsnet website, characters are displayed clearly but small on the UX PC.

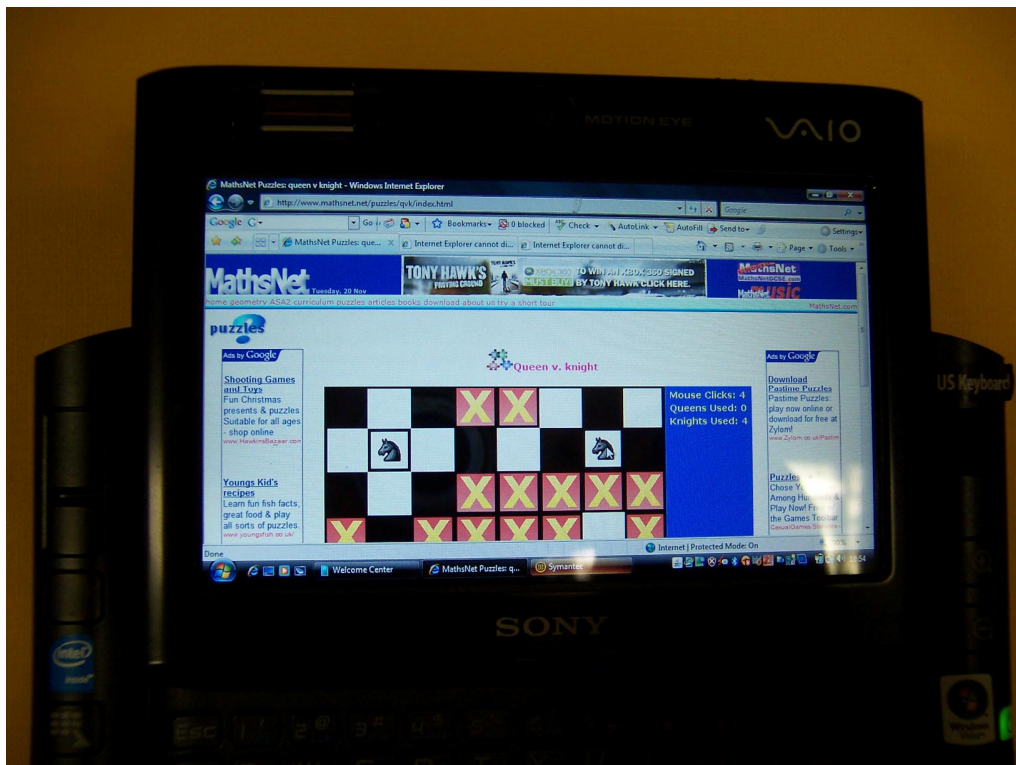


Figure 11 A game from the Mathsnet website played on the UX PC. The downloading is slow.

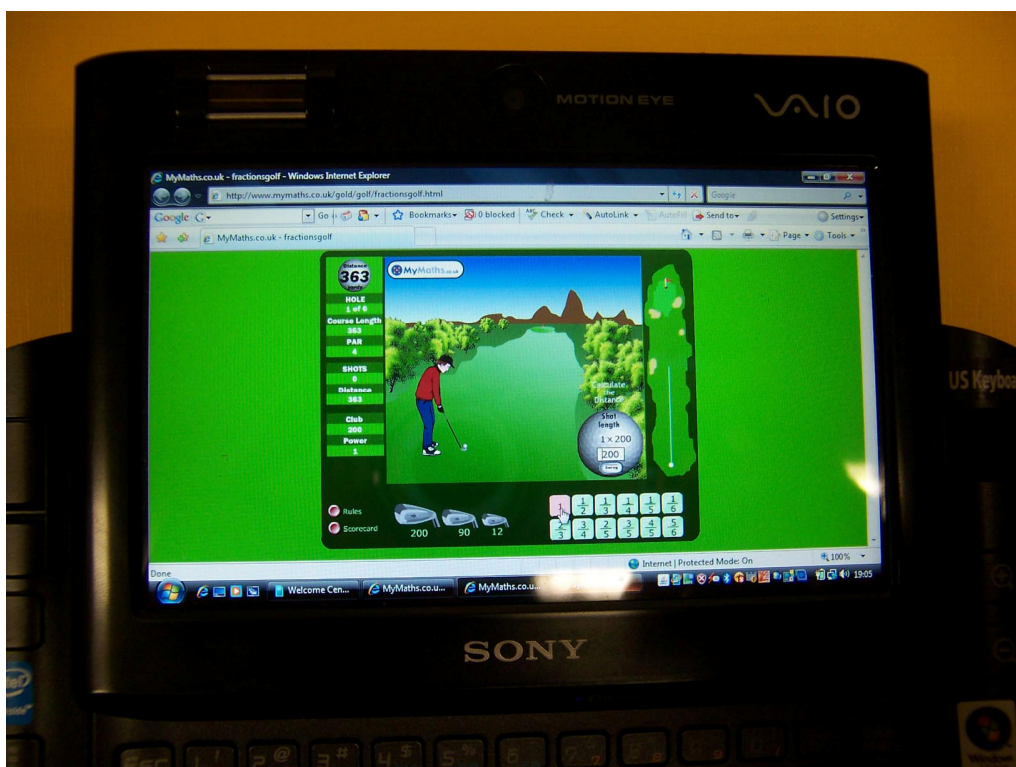


Figure 12 A mathematical game called “Golf” on the MyMaths website is playable on the UX PC but some characters are very small.



Figure 13 Games from the BBC Bitesize for GCSE revision can be played on the UX PC. The games cover different subjects including mathematics.

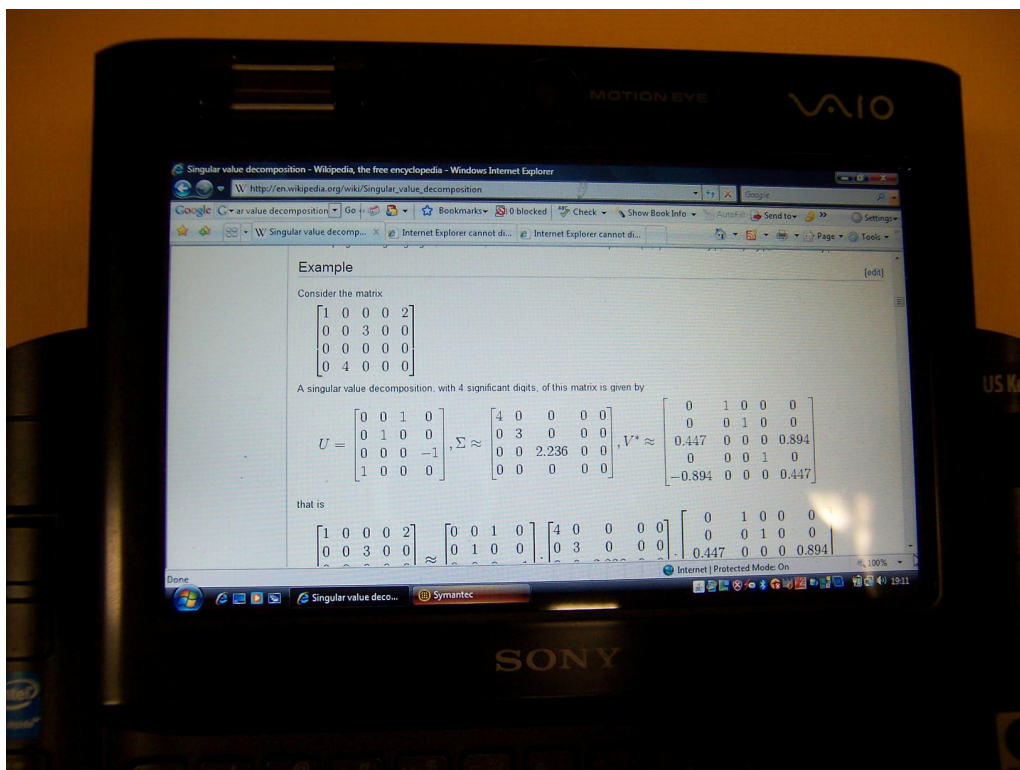


Figure 14 A Google search for “Singular value decomposition” on the UX PC.

Chapter 3. The HP iPAQ (Personal Digital Assistant or PDA)

Introduction

This PDA is made by Hewlett-Packard Development Company (2005). It is one of the HP iPAQ hx2100 Pocket PC series and is powered by Microsoft Windows Mobile™ Version 5.0 for Pocket PC, which includes Windows Media Player 10 Mobile, Internet Explorer Mobile, PowerPoint Mobile, Word Mobile and Excel Mobile.

Useful Features and Constraints:

There are some useful features for learning, such as:

- Composing and sending email messages (12 items at a time), although attachments cannot be opened.
- Browsing web pages on the Internet, although some large websites cannot be displayed.
- Using Word Mobile to create and save documents. However, when writing an equation, there is no way of showing a superscript or a subscript. Microsoft Equation Editor software is not included. Symbols cannot be inserted, so it is difficult to input the Greek letters which often appear in mathematics expressions.
- Using PowerPoint Mobile to open and view slide show presentations created on your computer. You can copy a presentation to the PDA via a storage card (see www.hp.com/go/ipaqaccessories) or download a presentation from the Internet or obtain a presentation by synchronizing with your computer.
- Using Windows Media Player 10 Mobile that can be downloaded free from Microsoft to synchronise your music, videos and recorded TV to the PDA. Windows Media Player 10 Mobile can automatically convert video and recorded TV during synchronisation to an optimized and size reduced format for better viewing on the PDA.

Internet Connection

Since the PDA tested has no built-in WiFi function, a WiFi adapter is needed. Before installing the adapter, you need to connect the PDA to a PC in which Microsoft Active Sync software (free downloadable) is already installed. After the registration between the PDA and the PC, you can use wireless network provided your PDA is in a wireless range. The login process is confusing: after you enter your user name, password and press the “submit” box, you still see a login page, asking for login information again. Despite this you may already be logged in successfully, and entering a website address (URL) in the address box on screen will display the appropriate page.

The Results of Testing for Maths Learning by Using the PDA:

1. Testing www.mymaths.co.uk

The “Home” page is displayed, but the hyperlinks in the sub-menu are not. Perhaps the language used to write the webpage cannot be recognised by the PDA.

2. Testing www.mathcentre.ac.uk

The “Home” page can be displayed but the whole website cannot be downloaded (See Figure 15).

3. Testing www.mathsnet.net

The layout of the “Home” webpage is very different from that of the original website. The contents cannot be displayed and downloaded.

4. Testing www.mathtutor.com

The display of home page is clear and the links work. However, a web page on the website containing video tutorials (<http://www.mathcentre.ac.uk/students.php>) cannot be found. Some learning material, which should be viewable online by pressing “View Online” does not appear. The layout of the webpage is changed.

5. Testing the Google search engine

The Google search engine works very well (See

Figure 16). Hyperlinks work as well (See Figure 16). Characters are displayed clearly but sometimes some of them are missed out due to distortion of the layout. The display of some notations is not always clear as the image size is reduced (See Figure 17).

Summary

The PDA is pocket sized and is very convenient to carry on the move. It can be connected to the Internet by using a WiFi adapter and also can be used for receiving and sending emails, so mobile learning is possible. However, because its memory is very limited, many video games cannot be played and many websites cannot be shown. If an email has an attachment, the email may not be received, or the attachments cannot be opened.

Using an expansion memory card, PowerPoint slides or video games can be transferred from a PC to the PDA and the user can view them.

The Word Mobile application is useful and has some simple editing functions.

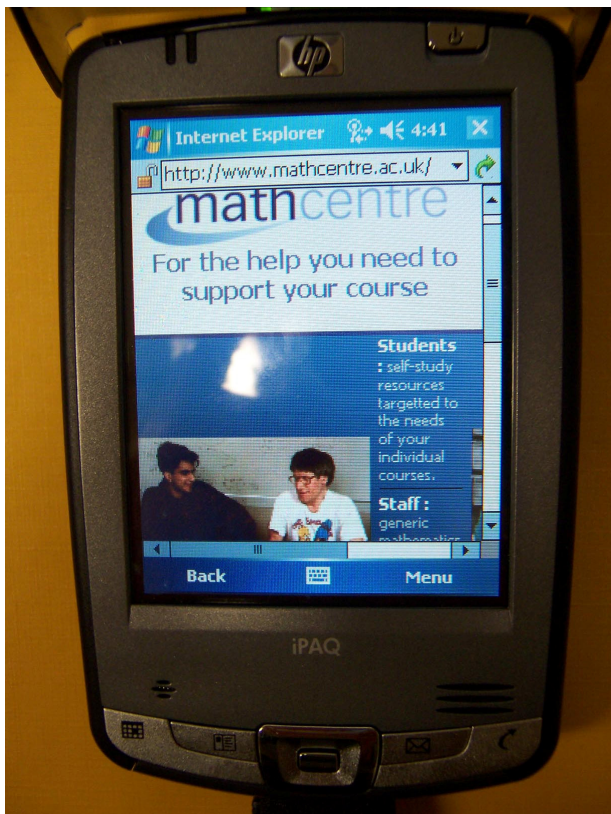


Figure 15 The home page of Mathcentre is displayed on the PDA. However, the whole website is too large to be downloaded

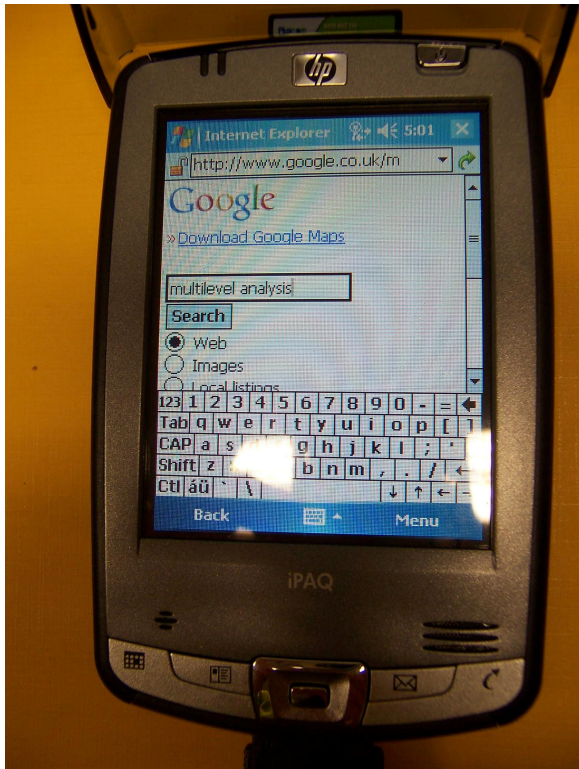


Figure 16 A Google search works well on the PDA. An on-screen keyboard is easy to use.

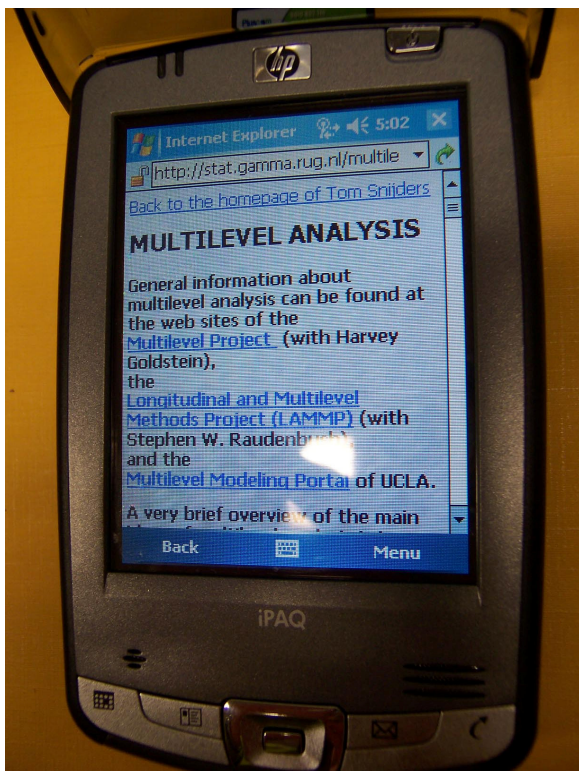


Figure 16 Hyperlinks work well in a Google search. The character display is good.

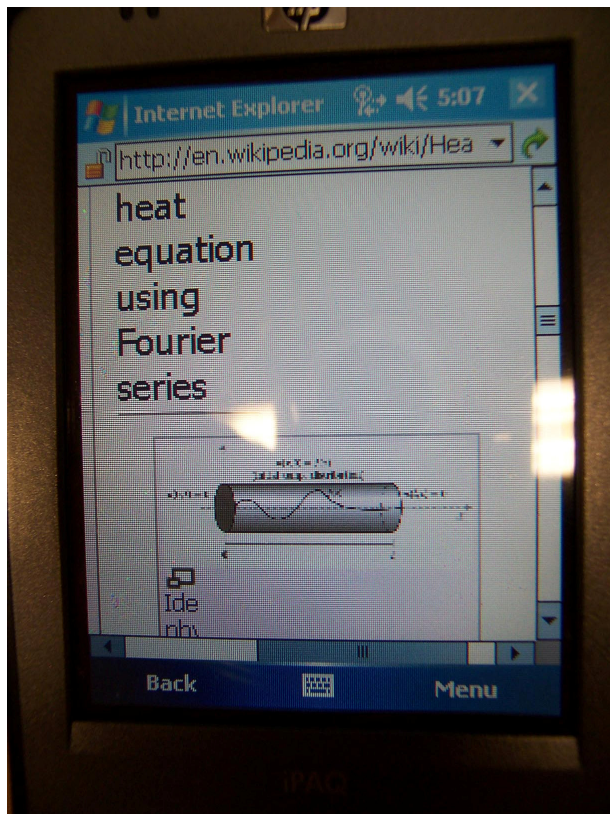


Figure 17 A Google search for “Heat equation”. Some characters are fuzzy in the graphics and the distortion of layout makes some letters disappear.

Chapter 4. Sony PlayStation Portable (PSP) 1003

Introduction:

The PSP system includes an AC Adaptor, a battery pack, headphones, and a built-in speaker. On either side of the PSP screen are 4-buttons; one set is for directional control and the other set for game specific functions.

Useful Features for Learning:

- Playing video games
- Accessing the Internet (Wireless LAN)

The PSP can also display photos and play music. The requirements for the connection to the Internet and wireless network are as follows:

- A subscription to an Internet service provider
- A network device, such as a DSL or cable modem
- A wireless LAN access point such as a wireless broadband router
- Settings for the access point.
- A PC

The use of a Memory Stick Duo™ allows the user to transfer data from a PC to the PSP; this can be very useful when downloading games or videos. The problem is that PSP only recognises the games made by PlayStation and videos in the MPEG4 format.

Internet Connection

Connecting to the Internet is not straightforward. On the “Home” page, using the directional keys on the left, you move a bright spot to a global sign, then to a “WWW” sign, then press the ⊗ function button on the right. This causes a login page to appear. Using the circle button on the left, gently press it and move a cursor to one of the boxes