# Extra Sensory Perception – Extending the Power of QM Perception

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## Abstract

Initial experience of using Question Mark Perception for Web-based assessment was presented at the 2nd Annual CAA Conference (McCabe, 1998). At that time Perception had been released as a commercial product for barely a month and had been used for formative assessment only. Confidence gained during the 1997/8 academic year has led to the extension of its use for summative assessment during 1998/9. Formal exams within the Faculty of Technology have been successfully conducted in mathematics, astronomy and computer science using Perception, in addition to the routine use of Question Mark Designer.

Besides the obvious benefits of greater accessibility to Perception tests, it has been possible to develop variants of existing question types, e.g. multi-numeric, and to exploit the more open system with custom questions. Perception Version 2, scheduled for release in July 1999, includes many new features and improvements.

## Introduction

Both Question Mark Designer and Question Mark Perception tests are used routinely in the School of Computer Science and Mathematics. QM Designer has been used increasingly for both formative and summative assessment over the past five years. A typical first year unit now requires a student to take five computer marked tests at regular intervals during a semester. Although Designer allows tests to be developed rapidly with a variety of standard question types, it is relatively inflexible in this respect

Perception (McCabe, 1998) may be regarded as the on-line equivalent of QM Designer and QM Guardian, incorporating facilities for administration, security and scheduling as well as authoring, delivery and reporting. It was initially used for formative assessment and has been used for summative assessment during the past 1998/9 academic year. The obvious benefit of using Perception is its greater accessibility, with straightforward access to tests via a Web browser. Less obvious is its greater flexibility. Perception allows variants of existing question types to be authored relatively easily and enables scores for partially correct answers (Beevers,1999) to be awarded more reliably. Furthermore it has become possible to incorporate new customised question types within tests. Since many subject areas have specialist requirements, the ability to add to standard question types is of great benefit.
Culwin (1998) and Whittingham (1998) both provide good examples of new question types.

## Conversion from Designer to Perception

The ability to import tests into Perception either from plain text files or existing Designer (QDL) libraries has enabled tests to be set up quickly. Figure 1 shows an assessment Web page, which accesses a large databank of 3000 multiple choice questions converted from text files. Both open self-assessment tests and secure coursework tests are delivered from the same page. The storage of questions within hierarchical topics, cf. Windows folders, allows different sets of questions to be selected from the same databank easily. Test reporting is also linked directly to the page, allowing rapid checking of results by both staff and students (Figure 2)

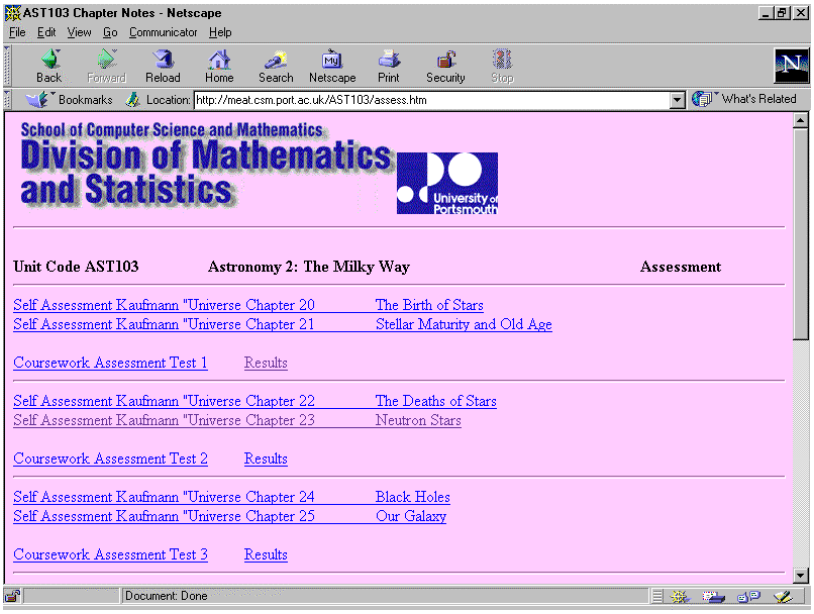


**Figure 1 Large-Scale Question Bank Conversion and Delivery**

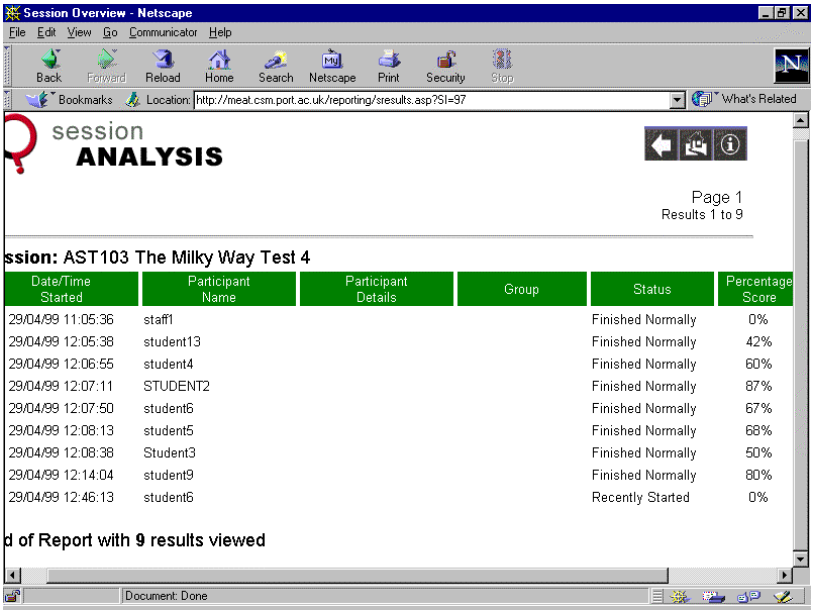


**Figure 2 On-line Test Results**

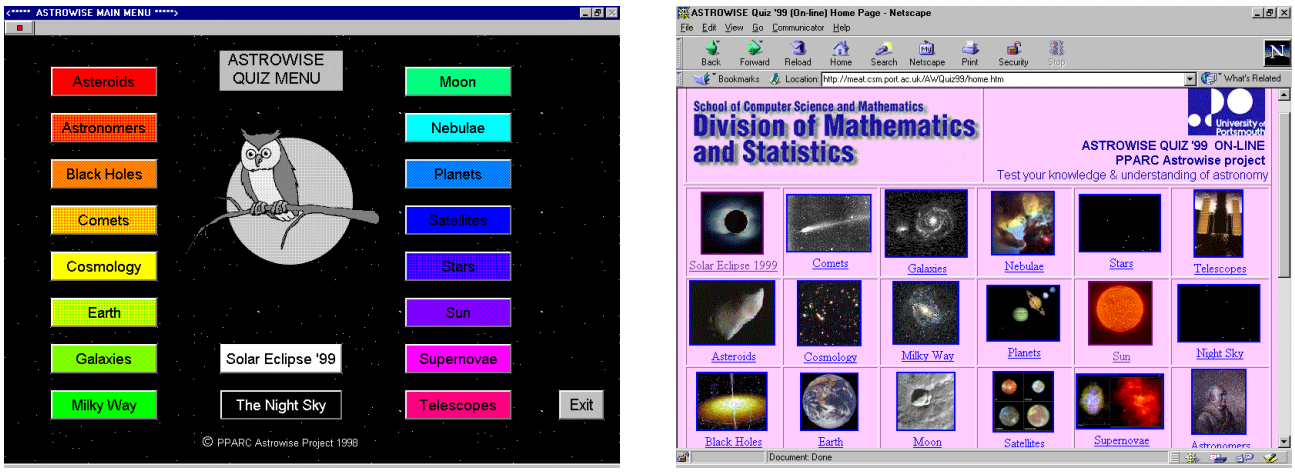


**Figure 3 Conversion of Designer Tests (left) to Perception (right)**

In the PPARC Astrowise Project for the public understanding of science, a bank of 200 questions on astronomical topics, including the 1999 total solar eclipse, was developed using QM Designer. Conversion of the question bank using Perception enabled the same tests to be delivered both locally and on-line (Figure 3). Other tests have been submitted electronically in plain text, QML text or Designer library format, converted and made available for on-line delivery. Hence lecturers without access to Perception Question Manager can still develop their own tests, even though the use of the QM wizards and dialogues is probably the quickest route for authoring new questions. Once published to the server, completed tests can be embedded seamlessly within other on-line courseware material.

## Numerical Questions

Two commonly cited limitations of Designer numeric questions (e.g. Lawson, 1998) are its inabilities a.) to handle more than one numeric answer in a single question and b.) to use randomly generated numeric parameters in questions and answers (e.g. Thelwell 1998, 1999).
Figure 4 shows how questions with more than one numerical answer can be developed. By using question outcomes, each answer can be scored independently or specific answer combinations can be scored separately. By including superscripts, the mantissa and exponent in scientific notation, e.g. $3.3 \times 10^{8}$ , can be entered and marked independently. Subscripts can be used for chemical formulae (cf. Whittingham 1998).

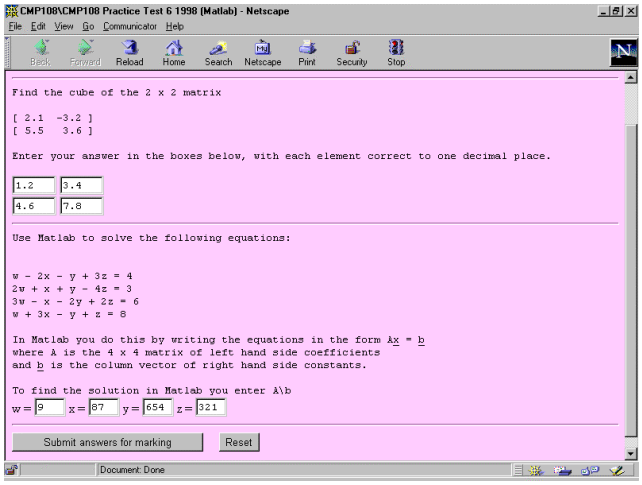


**Figure 4 Multiple Numeric Answers**

A calculator, spreadsheet or more sophisticated software application may also be used to support the answering of numeric questions. In Figure 5 the Maple computer algebra system is being used to plot a graph in order to find the correct answer.

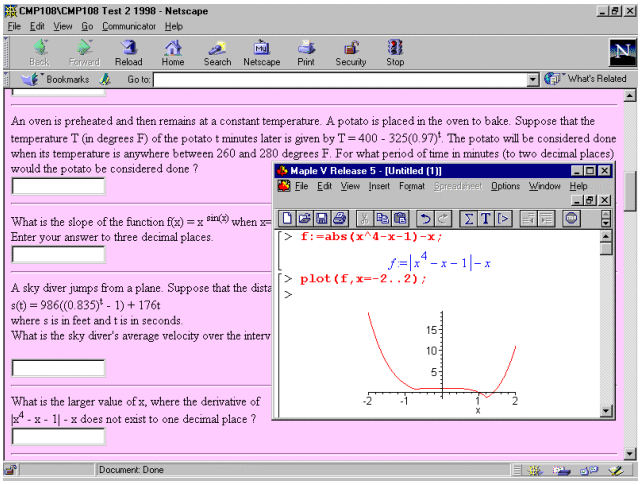


**Figure 5 Numeric Question with Software Support**

Perception wizards and component dialogue boxes provide a user-friendly means of authoring rigidly defined questions. It is harder to include the automatic generation of random numerical parameters, where the values need to be generated differently each time the test is run. Several different approaches have been tried using Javascript and Java within standard Perception questions.

## Javascript Randomised MCQ

The original approach was to insert Javascript into the Question Mark-up Language (QML) used by Perception. The only question types, which are readily randomised in this way, are the multiple-choice and multiple-response type questions. The radio button (or check boxes) associated with the correct answer(s) are fixed, but they can be shuffled when presented on screen. By using Javascript within Perception, random numbers are generated for the question stem, the correct answer(s) is calculated and suitable random distracters generated. A similar approach could be used within Perception to select a sample from many different text distracters.

Unfortunately, it was found that test feedback did not function exactly as desired, since randomisation caused a question to be displayed with different numerical parameters from the one answered. The awarding of marks is nevertheless consistent with the original question, so a fixed feedback message has to be used instead. Furthermore, there is a potential security problem, because an intelligent student could ascertain the correct answer purely by viewing the source code!

It was impossible use Javascript to generate a random number and get Perception to accept it as the answer to a standard numeric question, since the numeric answer has to be specified as a constant beforehand.

## Javascript Randomised Numeric Question

A work-around for implementing a numeric question in Perception using Javascript is to display it within a multiple-choice question. Depending on the numeric answer entered, the user is asked to select one of several radio buttons, so that Perception can process the multiple-choice question in the normal way. The method works, but is clearly unsatisfactory.

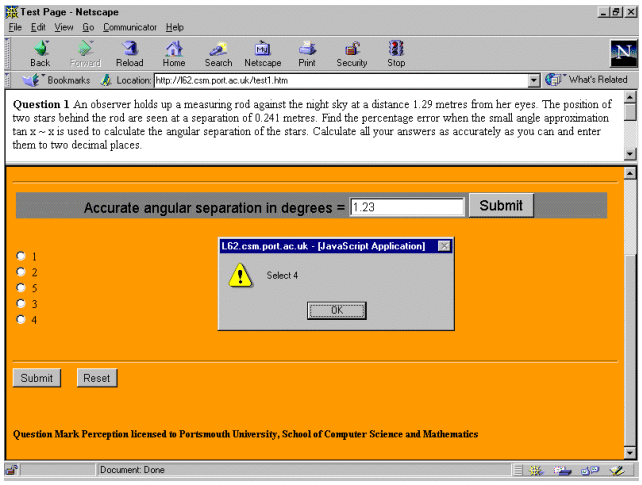


**Figure 6 A Randomised Numeric Question using Javascript**

## Javascript Randomised and Staged Questions

Perception allows the passage through questions to be modified depending on the responses to previous questions. A question may require two or more staged answers. Correct answers allow a student to proceed rapidly to later stages of the question, whereas an incorrect answer results in the display of intermediate stages and hints needed to derive the correct answer, with lower marks then awarded for the correct answer. An immediate problem in trying to achieve staged questions is that each time a jump is made to a different stage in the question, the original randomised variables are lost.

The only way found to get around this problem was to place Perception inside a frameset and keep all the variables in a separate window from Perception. Although somewhat inelegant, it works! It was also found that when more than one numeric-type question was displayed, the Javascript variables interfered with each other, so it was again necessary to use the frameset procedure to get round the problem. Overall the question-setting procedure using Javascript can only be regarded as moderately user-friendly.

## Java Randomised Numeric Question

A more satisfactory way of extending Perception, and randomised questions in particular, is to incorporate custom Java applets. Question Mark Computing supply a basic template for the Java applet, but the programming has to be done by the question developer.

A trial method developed at Portsmouth allows user-friendly setting-up of random numeric questions. Questions all use the same Java code or class, and need three (or four) data items to be inserted by the user, which are then sent into the Java applet as parameters. These four items are:

1. The random numerical parameters to be included in the question
2. A formula for the correct numeric answer
3. The error permitted in the answer

4. The optional width of the text box for the answer, with a default size in the applet if this item is not entered

Random numbers in the question are entered in a standard format, e.g. $p$2.0$6.5$ creates a variable p and assigns it a random value between 2.0 and 6.5 inclusive. The answer is displayed using postfix notation, e.g. qba-/d+ specifies an answer of the form
d + [ ( a - b ) / q ] . The notation has been modified to include standard unary operators, e.g. cos (x) is entered as x$cos$ . The resulting numeric parameters may then be embedded within the text of the question. The authoring and display of a simple question is shown in Figure 7.

Since Perception does not handle it automatically, the applet code ensures that, when required, the correct feedback is given, including the correct answer and the answer given by the student. Nevertheless, a staged question does still seem to require the use of a separate frameset, as in the Javascript implementation. It is hoped that the eventual method used will be more elegant than the Javascript approach once difficulties with the beta version of Perception V2 have been resolved.

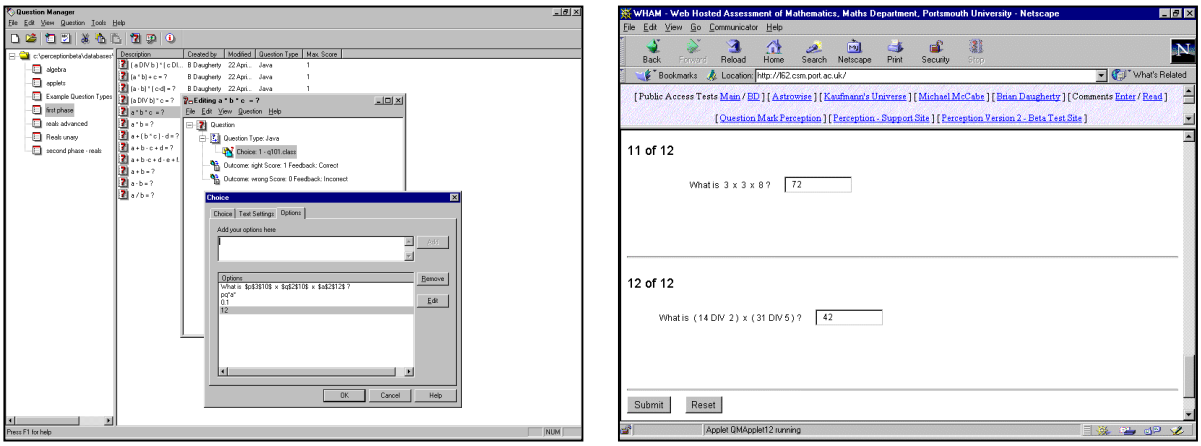


**Figure 7 Authoring a Randomised Numeric Question using Java**

## Exam Protocol Issues

Perception has been used routinely running under Microsoft Personal Web Server (PWS) and with Access databases. The Security Manager made it straightforward to set up exam userids and passwords, allowing regular tests to be scheduled for different groups of students. While a Windows NT server and Oracle databases provides a more robust system for larger numbers of users, it has been found that PWS and Access can certainly cope with moderate demands of at least 50 concurrent participants. The exam protocol used for QM Designer tests has been adapted to ensure that excessive demands are not placed on the server. Students log in when they arrive, but must wait before beginning a summative test (Figure 8). More particularly, simultaneous submission of a single test block by all students at the end of a formal exam is avoided. For informal self-assessment, when data logging is not required, the problem of excessive demands on the server has not arisen.

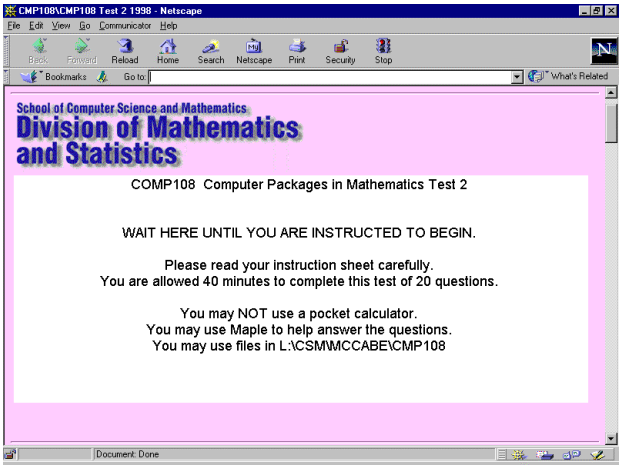


**Figure 8 Banner at Start of Formal Test**

## Perception Version 2

Version 2 of Perception is scheduled for release around July 1999. Among the new and improved features to be included are:

- desktop tryout – allowing the behaviour of questions to be tested during authoring
- easier authoring – including new wizards and multimedia
- better reporting and security
- simpler test publishing onto the server

## Conclusion

Perception is becoming a powerful tool for on-line computer assisted assessment, both for formative and summative tests. It provides a comprehensive system for the authoring, delivery, reporting, security and administration of standard objective tests and exams, and can avoid the need to “reinvent the CAA wheel”. Furthermore, it has been demonstrated that developers, who wish to add their own new question types and create structured tests, can extend and adapt Perception to their needs. A range of different methods, using Javascript or Java, have been tried out. Further improvements to Perception are on the way.

*extra = being more than what is expected, additional*

*sensory = relating to those structures within an organism that receive stimuli from the environment and convey them to the brain*

*extra sensory perception = the supposed ability of certain individuals to obtain information about the environment without the use of normal sensory channels*

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Maths assessment http://meat.csm.port.ac.uk/cmp108/assess.htm
Question Mark Computing http://www.qmark.com