National College of Ireland

Usability Testing Report For Brainpower

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1 Summary

This report presents the findings of usability testing undertaken on Brainpower's recently developed web-application which provides support to maths students. The application allows teachers to create, edit and author interactive e-learning assignments.

This research was conducted by the National College of Ireland and usability testing took place in NCI's usability laboratory; National E-learning Laboratory (NELL).

Five students, who were representative of the applications target group took part in usability testing. Users were observed performing a set of tasks in NCI's usability laboratory and their behaviour was then analysed using Observer XT technology. Users also completed an on-line pre- and post-test questionnaire and participated in a post-test interview. The table below summarises the main issues that emerged during usability testing:

Mathematical Tools	All five students had difficulty in manipulating the **square root / fraction / division** and **bracket symbols** and tester intervention was called for in all cases.
Question Structure	All five students showed confusion in **selecting a paper first** before starting the actual test and were prompted with the error message. Three of the students expressed that they disliked the fact the system would only accept **one way of answering the question** when in reality there were various ways of coming up with the same answer. Two of the students failed to see that the question came in **separate steps** and they thought that they could input all of their answers for the one question line by line. Four out of five students failed to see that **pressing save** was a pre-requisite.
How to Guide	The majority of students found the how to guide useful; one said it kept to the point while another would like more detail given. One of the users would prefer it replaced with onscreen pop up hints.
Design and Navigation	Two of the students approved of the look and feel of the design with only one student showing a strong dislike of the layout.
Usability; Ease of Use	Observed behaviour and user performance tells us all students had difficulty using this system. All students also said that they did not find it a straightforward process and may have given up using it, had tester not intervened.
Overall Satisfaction	The students liked the principle behind the programme and the hints that were provided but in general they felt the application was frustrating to operate.

2 Introduction

2.1 National College of Ireland

National College of Ireland is a third-level education provider committed to advancing knowledge in its specialist areas of business, human resource management, accountancy, finance, computing and community studies. Full and part-time courses in these areas are offered through the college's three Schools; the School of Business, the School of Computing and the School of Community Studies. Research at National College of Ireland is regarded as a core activity embedded in the academic culture and contributing to the overall mission of the college. Lifelong learning and workplace learning represent National College of Ireland's historical and current sphere of interest. For further details see www.ncirl.ie.

2.2 Centre for Research and Innovation in Learning and Teaching

Research activities are directed toward the following objectives:

- Study, develop, design and access new models, principles, practices, tools, artefacts and settings arising from the use of technology to support learning.
- Support and promote discourse on the application of e-Learning and blended learning within business, government and education sectors.
- Monitor, benchmark, review and report on national and international e-Learning policies and activities.
- Develop new models of teaching and training that support blended learning contexts.
- Apply flexible technology supported approaches to enhance skills in the workforce.

2.3 The National e-Learning Laboratory (NELL)

The National e-Learning Laboratory (NELL) allows researchers to systematically explore and improve the use of learning and knowledge-based technologies. The laboratory consists of sophisticated hardware and software that can observe up to four participants simultaneously.

User behaviour and screen interactions are investigated using combinations of video and audio recording, screen-capture, precision keyboard & mouse logging and eye tracking.

NELL enables researchers to observe, record and analyse the behaviour of students interacting with e-learning resources.

This data allows researchers to evaluate the students' learning experience in terms of the quality of engagement, learning gain, efficiency, effectiveness and usability.

2.4 Brainpower Company Profile

The Brainpower application contains a bank of maths related questions for post-primary students. This software allows teachers to create their own interactive e-learning assignments, edit assignments using their own content and distribute it to students via email.

Students can then download the student tool and access the material and attempt the maths questions sent to them by teachers. This tool contains hints and tips on how to answer questions and students can view solutions at any time.

Brainpower is currently a BETA version and before completing development of this resource, Brainpower commissioned National College of Ireland to undertake usability testing on the student answering tool and produce a report detailing the student user experience.

3 Research Methods and Design

A user study was designed that would facilitate the observation of users of the website performing a number of tasks in close to realistic setting. The testing took place in NCI's usability laboratory; NELL.

3.1 User Study Protocol

All participants had to complete the following activities:

- Pre-test on-line questionnaire
- User was given a scenario and asked to complete tasks
- User behaviour was observed and recorded during observation using video and sound recording, interaction logging and eye-tracking
- Exit questionnaire
- Post-test interview

3.2 Users

"It takes only five users to uncover 80 percent of high-level usability problems"

Jakob Nielsen (www.useit.com)

During this study, five National College of Ireland first year students participated in usability testing. Aged between 17-32, all of these students had sat the Irish Leaving Certificate Mathematics Examination in the last two years, at least a minimum of pass level..

In the pre-test questionnaire, users were asked to supply details about their backgrounds and experience with computers. They were also asked to comment on what they currently use as additional supports when studying for exams.

Please see Appendix 1 for an example of pre-test and post-test questionnaire.

3.3 Test set-up

For this usability study, Brainpower provided a test set-up, allowing test users to complete an exam paper with three maths questions.

3.4 Scenarios

Each user was given the following scenario:

User A is a 6th year (or repeat) student who is studying for Ordinary level maths in the Irish Leaving Certificate. The class teacher has used Brain Power authoring tool to create 3 e-learning assignments related to the mathematics course. The teacher then emailed the student, asking them to complete the three exercises.

3.5 Specific Tasks

The **Student Answering Tool** was tested during this project and users were asked to complete 3 mathematics exercises during testing sessions.

Areas that were tested:

- Log-in to system
- Access questions
- Enter a solution, using various steps and selected symbols
- Access solution
- Can check results/feedback

4 The User's Experience

The following section will present data and commentary on each of the individual user experiences and behaviour throughout tests. In is broken into 6 sections:

1. The User Profile
2. An Overview of Observation
3. Eye-tracking maps of Orientation phase (collected for 3 out of the 5 users)
4. An Observation Table
5. Post-Test Interview
6. On-line usability survey

Several critical episodes that illustrate areas of difficulties that users encountered during testing are compiled on the accompanying DVD.

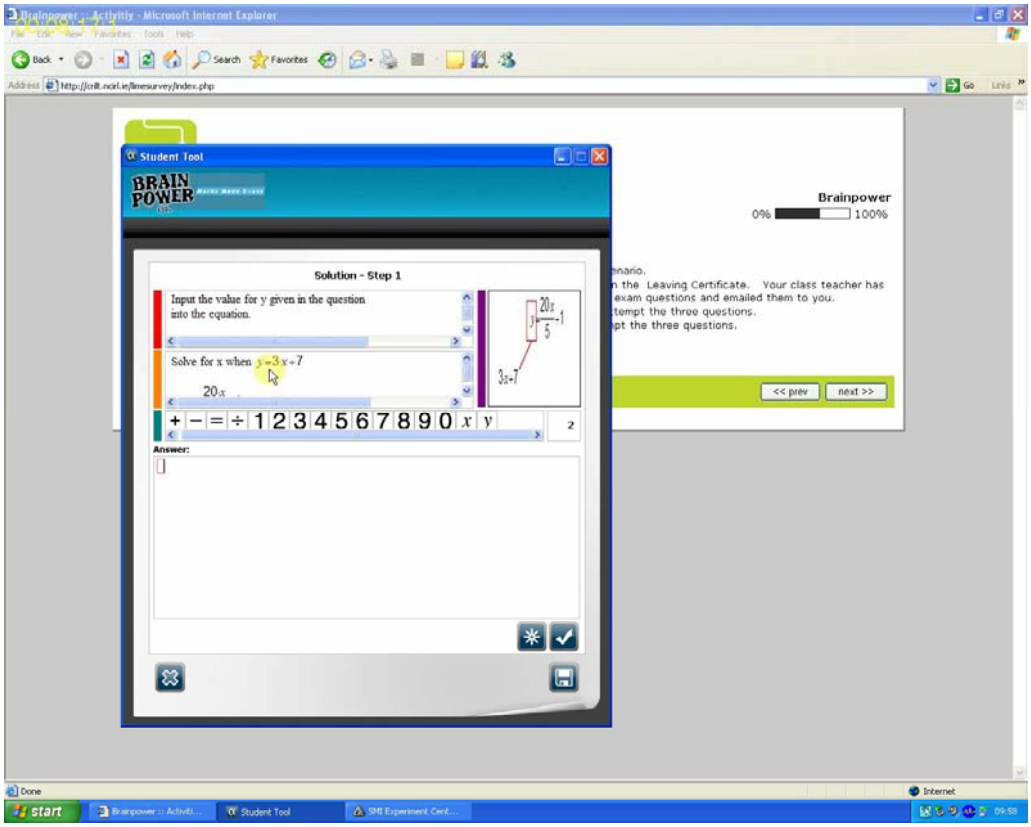

Figure 1: An example of Brain Power screen – Solution Screen

4.1 User 1

User profile

The user profile describes the user's demographic data and prior experience with computers.

User 1	Female, Age: 17-32. She is currently studying for a degree.
Computer use	This participant occasionally uses a desktop computer however a laptop is her preferred choice (uses on a daily basis). She always uses her phone and mp3 player/ipod for the internet. User 1 said she always uses her computer for programs such as word, browsing the internet, using facebook, sometimes for email, on line shopping, games, e-learning and she has never used skype. User 1 has a broadband connection.
User information	User 1 undertook her leaving certificate in 2007 and did ordinary level maths and to help her study she took grinds, tutorials, viewed past papers and her school website. In her current course there is no maths involved.

Overview of Observation:

The Overview of observation contains a short narrative describing the highlights of the user's experience.

User 1 incorrectly selects "test module images" first rather than selecting the paper, she is prompted by an error message and after some hesitation clicking various buttons eventually finds the test paper and proceeds to take the test. She read the how to guide, added a step to the first question and typed the first part of the formula correctly. Next she tried to select part of the formula using the forward arrow key and pressed space bar, brackets are placed around the formula and she gets confused and deletes it. She made this same mistake two more times. The tester intervened and typed the correct formula for her, she was also unaware that she needed to press save. She speedily completes the rest of question1. Jumping to question three next before question two she made around eight or nine wrong attempts at typing in the formula until the tester intervened (the solution box is not provided for this question) the tester gave her the answer sheet and then she sped through it.

On had difficulty placing the smaller number before the square root symbol, after many failed attempts the tester had to intervene. She finished the final two parts of the question with ease only after she figured out how to manipulate the fraction and square root signs.

Orientation Phase:

The orientation phase describes what people do and look at the first time they see the website and in this experiment, this user first focuses on the Solution Screen.

Solution Screen

This eye tracking data is based on the first minute after the user first sees the solution screen.

User 1 spent the first 7 seconds examining the orange question area. She then looked at the purple area containing a figure of the solution briefly before quickly looking at the green area containing the numbers and back to the orange question area. She then spent the next 8 seconds referring to the task sheet.

When user 1 returned her gaze to the screen, she quickly glanced at the answer area, and then drew her attention to the red question area. The rest of the time was spent quickly looking over each area for a second time.

Using eye-tracking, the following recordings of the orientation phase are available:

- a focus map highlighting the areas where the user focused their gaze (see below)
- a scan-path movie showing the sequence of fixations (see DVD)
- a gaze movie showing the gaze position (see DVD)

Please see the focus and heat maps below for the areas that have been examined and ignored during orientation phase.

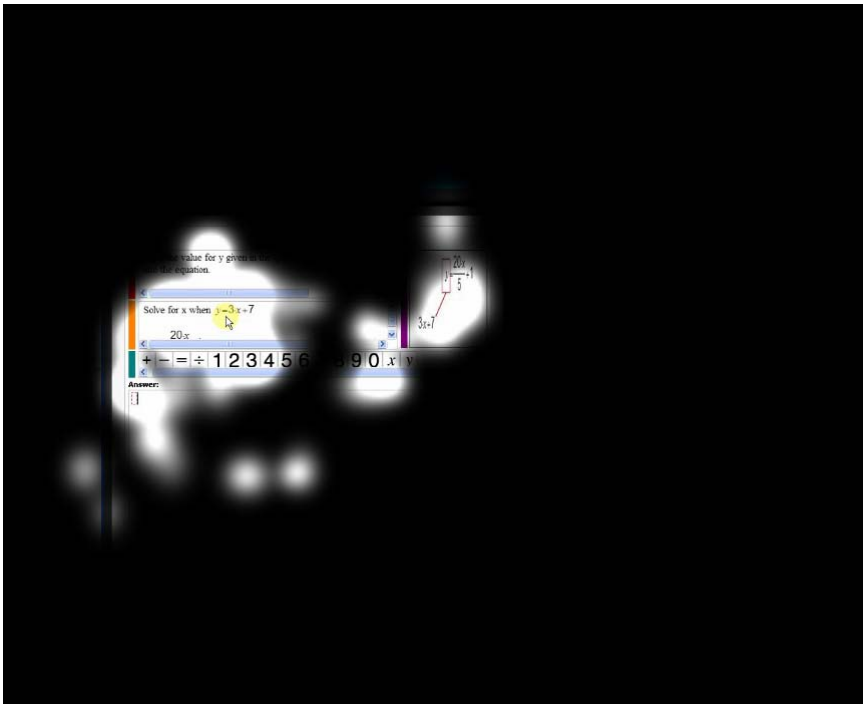

Figure 2: User 1 focus map of the solution screen (The white area shows the area looked at during this time, the black represents the area the user ignored)

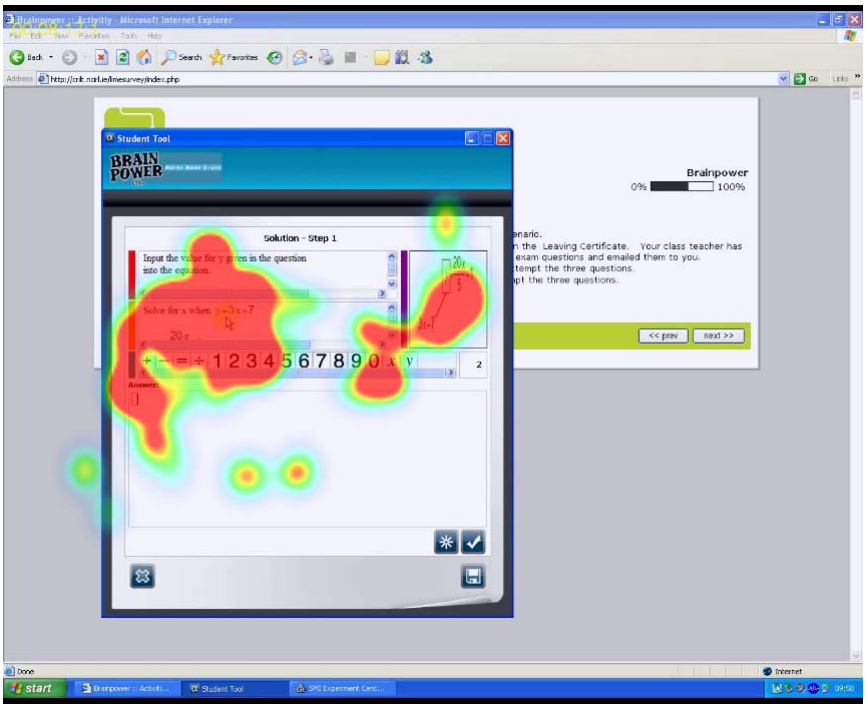

Figure 3: User 1 heat map of the solution screen (The coloured areas signify parts of the screen which were focused on most)

Observation Table:

The observation table on the next page presents a summary of users' behaviour during testing, highlighting the performance during each of the tasks. During testing, we identified a number of **common user errors** which are listed below.

- **Selecting the paper:** Each of the five users failed to select the paper first before selecting the start test button this prompted them with an error message.
- **Brackets:** When they tried to add the **+ sign** if they pressed the space bar after it brackets were placed around the entire formula which caused confusion. They could not figure out how to delete the brackets without wiping the entire formula and so had to retype their answer once again. This happened many times and tester intervention was always needed to proceed.
- **Answers underneath each other:** Some users typed each answer to the four parts of the question on a line one after the other without realizing that you needed to press save after each part to bring you forward to the next part of the question. Tester intervention was needed when this occurred.
- **Square root sign:** They had difficulty in highlighting the correct part of the formula in order to add the smaller number before the square root sign.
- **Fraction sign:** They had difficulty in selecting the correct part of the formula in order to add the fraction sign.
- **Division sign:** They showed confusion when trying to add the division sign to the formula.
- **Saving:** They failed to realize that they needed to press save after answering each step in the question.

Observation table - User 1

TASKS (User 1)	Time (secs)	Errors	Observer comments	Post interview, user	Success
Task 1: Question selection	94	1	Failed to select the paper first.		2
Task 2: Question 1	1216	9	Problem deleting brackets. Tester intervention needed.		5
Task 3: Question 2	589	1	Difficulty in manipulating the square root sign and the fraction sign. After tester intervention she sped through the remaining questions.		5
Task 4: Question 3	716	2	Skipped to task 4 before task 3. Made nine attempts typing in various formulas then called for tester intervention.	*If you came across this and you were on your own you'd be a long time working it out*	2

Success Rating

1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

Post Test Interview

Summarises users' comments made in the post interview.

Area	User 1
How to Guide	She liked that the "how to guide" it was short enough and she said it kept to the point if it was any longer she would have lost some interest. She liked that the solutions where at hand if she was stuck. When asked what would happen if she came across it without any notes or instructions she replied: *If you came across this and you were on your own you'd be a long time working it out!* *Without reading the book I wouldn't know how to add a step*
Mathematical Tools	She said she found inputting the numbers and signs easy enough but the red highlighting irritated her. She had difficulty figuring out how to use the square root sign and the fraction sign but on reading the guide sped through the rest of the test. She ran into problems deleting brackets from the formula and became quite frustrated when she had to retype the formula from the beginning, this happened to her numerous times until the tester had to intervene.
Question Structure	She didn't like that the tool only accepted one way of providing the correct solution. *Like I'd do math's one way and you'd do math's another way…… it was getting real frustrating that you could only do it one way* She said she would like more information given in the question stem; the sentence was too brief it could be more descriptive.
Design / Navigation	She thought that the save button would save her progress to date on the system as seen in other applications, she thought that she could log back in at a later stage and see how she scored. She found the solution box difficult to see unless she expanded it; sometimes she wasn't sure if she was looking at a plus sign or a division sign.
Satisfaction	She liked the resource and that the hints were provided but wished that the system could accept different ways of solving the equations.

Post-test usability Survey Summary

After testing, users were asked to complete an on-line survey to rate different usability aspects of this resource. Each attribute was given a rating out of 100%.

Usefulness	**67%**
This website meets my needs	3
It does everything I would expect it to do	3
This website allows me to do the things I want to do	5
Ease of Use	**19%**
It is easy to use this website	1
It is easy to find what I am looking for	1
The structure of this website is logical and easy to follow	1
If I make a mistake, I can find my way again easily	4
Learnability	**33%**
It is easy to learn how to use this website	1
I learned how to use this website quickly	1
I can easily remember how to use this website	5
Satisfaction	**50%**
I like this website	3
This website works the way that I want it to work	3
This website annoys me	5
I like how this website looks	5
I would recommend this website to a friend/colleague	3
e-Learning	**38%**
I found the content relevant to my needs	5
I found the content at the right level for me	5
The structure was presented in a clear way	3
Feedback on activities was presented in useful way	3
I found in possible to progress through this resource on my own	1
I found this tool fun, engaging	1
I found it easy to see my progress through this course	1
I can adapt this course to my own needs	1
Total	**41%**

1= strongly disagree; 5=strongly agree

4.2 User 2

Profile for user 2

User 2	Male, Age: 17-32. His highest level of education is leaving certificate.
Computer use	This participant uses a desktop computer and a laptop on a daily basis. He always uses his phone but only sometimes for the internet and always uses his mp3 player/ipod for the internet. User 2 said he sometimes uses his computer for programs such as word , e-learning, always uses the internet for browsing, using facebook, email, on line shopping, games and he has never used skype. User 2 has a broadband connection.
User information	User 2 undertook his leaving certificate in 2008 and did higher level maths and to help him study he took grinds, on line notes viewed past papers and received notes from his teacher. In his current course user 2 said he uses a calculator.

Overview of Observation

User 2 incorrectly selects the test button first rather than selecting the paper, he is prompted by an error message and after some hesitation randomly clicking various buttons eventually finds the test paper and proceeds to take the test. He tries to work out the formula on paper first before looking at the screen. He typed the first part formula correctly but runs into difficulty when he tried to select part of it, he pressed space bar which places brackets around the formula, he gets confused and clears the screen. He read the guide and called for intervention as he seemed unsure how to get to the next part of the question. He was unaware that he needed to press save and that the question came in separate parts. He flew through the remaining parts without too much trouble once he was aware of this. He ran into difficulty placing the smaller number in front of the square root symbol but figures it out himself after reading the how to guide. The final task caused him difficulty, he could not work out the formulas himself without the solutions and after various wrong attempts he called for assistance, once given the answers he competed the task successfully.

Observation table - User 2

TASKS (User 2)	Time (secs)	Errors	Observer comments	Post interview, user	Success
Task 1: Question selection	165	1	Failed to select the paper first.		2
Task 2: Question 1	609	5	Problem deleting brackets. Does not press save. Tester intervention needed.		5
Task 3: Question 2	182	-	Difficulty manipulating the square root symbol. Reads the "how to" guide then speeds through the remaining parts.	*The square root… I wouldn't have been able to figure it out without the guide*	2
Task 4: Question 3	285	1	The solutions were not provided for this task. He typed in various wrong solutions before the tester had to intervene.		5

Success Rating

1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

Post Test Interview

Area	User 2
How to Guide	He said he found the "how to" guide very useful. *The square root… I wouldn't have been able to figure it out without the guide*
Mathematical Tools	He said he found inputting the answers fairly straightforward but it was not obvious to him that he had to save each answer. He ran into problems deleting the brackets around the formula and was only able to proceed once the tester intervened. He also ran into difficulty in placing the smaller number before the square root symbol.
Question Structure	He disliked the fact that each question came in parts he thought that he could do it all in one step, he found this a slow process. *I didn't realize you had to put it in step by step….I didn't think that you had to put them in separately*
Design / Navigation	He said the papers could have been named differently to make it more obvious that you were selecting a paper rather than the long file path ie: if they were split into topics and called question 1 of topic 1 etc He found the solutions image in the top right corner easy to see but failed to locate the button on task4 when it was not shown to him already. He said it was not clear what each buttons function was.
Satisfaction	He said he did not find it easy to work with, the structure was not as straightforward as it should be. It did not show him where he was going wrong after he was judged incorrectly, it could have been more descriptive.

Post-test usability Survey Summary

Usefulness	**75%**
This website meets my needs	4
It does everything I would expect it to do	5
This website allows me to do the things I want to do	3
Ease of Use	**31%**
It is easy to use this website	2
It is easy to find what I am looking for	3
The structure of this website is logical and easy to follow	2
If I make a mistake, I can find my way again easily	2
Learnability	**67%**
It is easy to learn how to use this website	5
I learned how to use this website quickly	2
I can easily remember how to use this website	4
Satisfaction	**65%**
I like this website	4
This website works the way that I want it to work	3
This website annoys me	2
I like how this website looks	3
I would recommend this website to a friend/colleague	4
e-Learning	**63%**
I found the content relevant to my needs	4
I found the content at the right level for me	3
The structure was presented in a clear way	2
Feedback on activities was presented in useful way	4
I found in possible to progress through this resource on my own	4
I found this tool fun, engaging	3
I found it easy to see my progress through this course	4
I can adapt this course to my own needs	4
Total	**60%**

1= strongly disagree; 5=strongly agree

4.3 User 3

Profile

User 3	Female Age: 17-32. She is currently studying for her degree.
Computer use	This participant occasionally uses a desktop computer however a laptop is her preferred choice (uses on a daily basis). She sometimes uses her phone and only occasionally for the internet and always uses her mp3 player/ipod for the internet. User 3 always uses her computer for word as well as browsing the internet and chatting to friends on line. User 3 has never used the internet to do online shopping, play games or used skype. User 3 occasionally uses the internet for e- learning. User 7 has a broadband connection.
User information	User 3 undertook her leaving certificate in 2008 and did ordinary level maths and to help her study she took grinds and viewed past papers. In her current course there is no maths involved.

Overview of Observation

User 3 incorrectly selected the test button first before selecting the paper. She types the first formula correctly but instead of pressing the result button she seems unsure and selects the clear button, it wipes the screen and she has to retype her answer again. She showed confusion on manipulating the division symbol and also when she accidentally added brackets to the formula, this happened many times throughout each question in the test. She was unable to clear them without wiping the formula and starting from scratch and this always called for tester intervention. Next she proceeded to add all four answers on a line one after the other and then seemed confused when judged incorrectly she was unaware that the question came in parts and needed prompting to press save. On question 2 she ran into difficulty trying to manipulate the fraction symbol which called for more tester intervention. On the final task after some hesitation and after typing in three incorrect answers the tester gives her a print out of the answer sheet and she flies through the remaining parts of the question and completes the task.

Observations User 3

TASKS (User 3)	Time (secs)	Errors	Observer comments	Post interview, user	Success
Task 1: Question selection	174	1	Failed to select the paper first.		2
Task 2: Question 1	1023	9	Presses the clear button instead of result button to judge answer. Confusion manipulating the division sign. Problem deleting brackets. Adds each answer underneath the other. Does not press save. Tester intervention needed.	On entering the division sign: *I got there in the end but I don't know how I did it* On entering each answer: *I didn't know that you had to put them all in separately*	5
Task 3: Question 2	450	4	Problem deleting brackets. Difficulty manipulating the fraction sign. Tester intervention needed.	*Highlighting the formula was frustrating the brackets were annoying*	5
Task 4: Question 3	309	1	The solutions were not provided for this task. She typed in various wrong solutions before the tester had to intervene.		5

Success Rating

1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

Post Test Interview

Area	User 3
How to Guide	*I thought it wasn't great, I had to read it over and over again it could have gone into more detail!*
Mathematical Tools	She said entering the symbols was hard and had difficulty using the fraction symbol and the division symbol, tester intervention was needed for her to proceed. She found getting rid of the brackets surrounding the formula frustrating. *I just found it difficult when every thing was in red*
Question Structure	She thought that she could type each part of the question on a line one after the other. She didn't know that you had to save each step, she thought she could press save at the end of the question. *When you were judged incorrect they could have shown you where you went wrong.*
Design / Navigation	She wrote in the questionnaire that she found it hard to use and to navigate. On the actual design and overall look she commented: *It's not very interesting …….I didn't really like it!*
Satisfaction	She wished that there was more detailed direction given on how to use the programme but appreciated the hints that were given for each question. *If I was doing the leaving cert I probably would use it because it shows you the answer at the top.*

Post-test usability Survey Summary

Usefulness	**58%**
This website meets my needs	3
It does everything I would expect it to do	4
This website allows me to do the things I want to do	3
Ease of Use	**50%**
It is easy to use this website	2
It is easy to find what I am looking for	4
The structure of this website is logical and easy to follow	3
If I make a mistake, I can find my way again easily	3
Learnability	**33%**
It is easy to learn how to use this website	2
I learned how to use this website quickly	2
I can easily remember how to use this website	3
Satisfaction	**35%**
I like this website	2
This website works the way that I want it to work	2
This website annoys me	4
I like how this website looks	4
I would recommend this website to a friend/colleague	2
e-Learning	**44%**
I found the content relevant to my needs	4
I found the content at the right level for me	3
The structure was presented in a clear way	2
Feedback on activities was presented in useful way	2
I found in possible to progress through this resource on my own	1
I found this tool fun, engaging	2
I found it easy to see my progress through this course	5
I can adapt this course to my own needs	3
Total	**44%**

1= strongly disagree; 5=strongly agree

4.4 User 4

User Profile

User 4	Female Age: 17-32. She is currently studying for her degree.
Computer use	This participant always uses a desktop computer and a laptop (uses on a daily basis). She always uses her mobile phone (without internet) and only occasionally uses a mobile device for the internet. She sometimes uses her mp3 player/ipod. User 4 always uses her computer for browsing the internet, and chatting to friends on line. She sometimes uses her computer for office packages such as word, excel etc as well as email and e-learning. User 4 never uses the internet to do online shopping, play games or use skype. User 4 occasionally uses the internet for e- learning. User 4 has a broadband connection.
User information	User 4 undertook her leaving certificate in 2008 and did ordinary level maths and to help her study she viewed past papers and got extra help from her teachers at school. In her current course she uses the internet, a calculator, and books.

Overview of Observation

User 4 failed to select the paper first before starting the test. On starting question 1 the test was briefly suspended due to a system error which the tester fixed. She read the how to guide and started typing the formula. She ran into difficulty when she had to add the division symbol and consults the guide again for help. She was unaware that she had to press save after she had typed the correct formula and seemed unsure how to proceed. She then entered the formula for step 2 on the line beneath step1; tester intervention was needed to explain that the question came in steps. She had difficulty on question 2 manipulating the square root function and the fraction sign the tester prompted her to read the correct part in the guide and she figured it out by herself. She made many incorrect attempts on question 3 so the tester gave her the answer sheet and only with this was she was able to complete the task.

Orientation Phase

Solution Screen

This eye tracking data is based on the first minute after the user first sees the solution screen.

User 4's attention immediately went to the green area containing the numbers and then went to the answer area. Duration of each fixation was a lot longer than user 1.

User 4 glanced back and forth between the purple area containing the figure of the solution and the answer area. She then spent a considerable amount of time studying the task sheet before returning her gaze to the screen.

Using eye-tracking, the following recordings of the orientation phase are available:

- a focus map highlighting the areas where the user focused their gaze (see below)
- a scan-path movie showing the sequence of fixations (see DVD)
- a gaze movie showing the gaze position (see DVD)

Please see the focus and heat maps below for the areas that have been examined and ignored during orientation phase.

Figure 4: User 4 focus map of the solution screen (The white area shows the area looked at during this time, the black represents the area the user ignored)

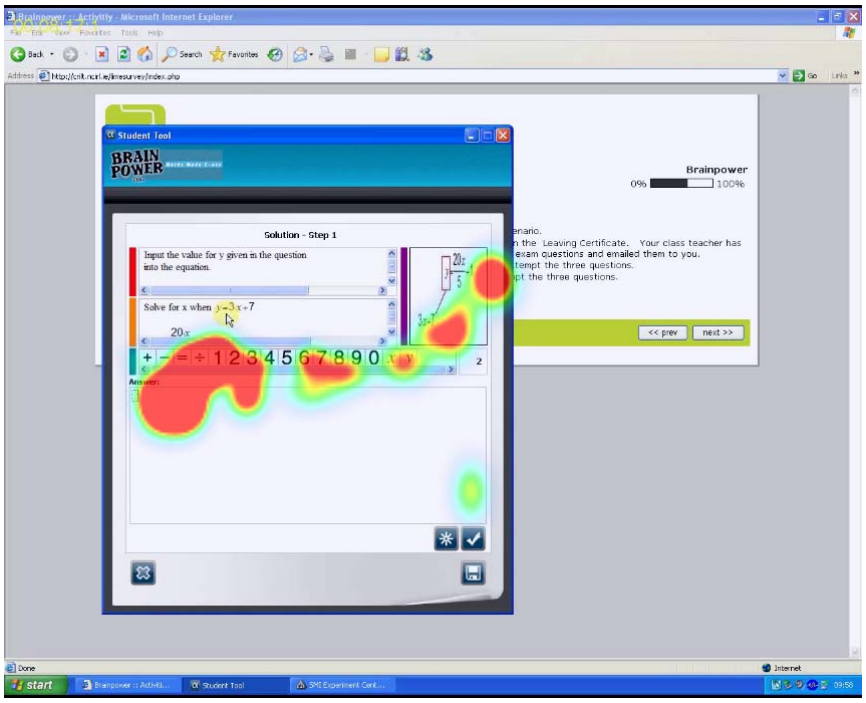

Figure 5: User 4 heat map of the solution screen (The coloured areas signify parts of the screen which were focused on most)

Observations User 4

TASKS (User 4)	Time (secs)	Errors	Observer comments	Post interview, user	Success
Task 1: Question selection	73	1	Failed to select the paper first.		2
Task 2: Question 1	813	6	Test briefly suspended due to system error. Confusion manipulating the division sign. Fails to see the solutions provided. Adds each answer underneath the other. Does not press save. Tester intervention needed.	*I didn't know that you had to save each stage* *When I went in to delete a little bit of it, it all went, it was frustrating!*	5
Task 3: Question 2	588	2	Difficulty manipulating the square root sign and the fraction sign. Tester intervention needed.		5
Task 4: Question 3	285	1	The solutions were not provided for this task. She typed in various wrong solutions before the tester had to intervene.		5

Success Rating

1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

Post Test Interview

Area	User 4
How to Guide	*Yeah that helped a lot if I hadn't seen it I would have been totally lost.*
Mathematical Tools	She thought she could type the numbers on the keyboard the rather than having to select them onscreen. She ran into difficulty manipulating the division sign, the square root sign and the fraction sign, tester intervention was needed for her to proceed.
Question Structure	She said the process of selecting the actual question was straight forward. She admitted to knowing what all the buttons were and if it wasn't clear she knew to use the roll over hints. She thought that she could supply the answer in different formats it wasn't obvious to her that the application only accepted one way of solving the equation. *I would rather work it out on the screen first so you can see where it's coming from* *I didn't know you had to type in just the answer.* It was not obvious to her that she had to save each part of the question to proceed.
Design / Navigation	She thought the overall look of the application was good. She would prefer if she could work out the formula herself on screen first and then type in an answer, suggested a scribble box in one of the areas.
Satisfaction	She liked that the solutions were provided in the top right hand corner it made it easier. She wished the programme would accept more than one way of formulating the correct answer.

Post-test usability Survey Summary

Usefulness	**75%**
This website meets my needs	5
It does everything I would expect it to do	4
This website allows me to do the things I want to do	3
Ease of Use	**88%**
It is easy to use this website	4
It is easy to find what I am looking for	5
The structure of this website is logical and easy to follow	5
If I make a mistake, I can find my way again easily	4
Learnability	**92%**
It is easy to learn how to use this website	5
I learned how to use this website quickly	4
I can easily remember how to use this website	5
Satisfaction	**90%**
I like this website	4
This website works the way that I want it to work	4
This website annoys me	1
I like how this website looks	5
I would recommend this website to a friend/colleague	5
e-Learning	**91%**
I found the content relevant to my needs	4
I found the content at the right level for me	5
The structure was presented in a clear way	5
Feedback on activities was presented in useful way	5
I found in possible to progress through this resource on my own	3
I found this tool fun, engaging	5
I found it easy to see my progress through this course	5
I can adapt this course to my own needs	5
Total	**87%**

1= strongly disagree; 5=strongly agree

4.5 User 5

Profile

User 5	Male Age: 17-32. He is currently studying for her degree.
Computer use	This participant always uses a desktop computer (uses on a daily basis), a mobile phone (without internet), and an mp3 player/ipod. He never uses a laptop computer. User 5 always uses his computer for browsing the internet, and chatting to friends on line. He occasionally uses the internet for on line shopping, e-learning, and playing games. He never uses the internet for skype. User 5 has a broadband connection.
User information	User 5 undertook his leaving certificate in 2007 and did ordinary level maths and to help with his studies, he viewed past exam papers. In his current course there is no maths involved.

Overview of Observation

User 5 ran into the same problem as all students of failing to select the paper first before starting the test. He spent quite a long time reading the how to guide and navigating over the interface before starting the test. He made several wrong attempts at typing in the formula even though the hints were provided for him; tester intervention was called for three times on task1. He showed confusion manipulating the division sign and ran into difficulty trying to clear brackets which he accidentally added to the formula. He needed prompting from the tester to press the save button. On question 2 he had trouble once again with the brackets and on manipulating the exponent symbol, tester intervention was called for twice. The final task he sped through quite quickly.

Orientation Phase

Solution Screen

This eye tracking data is based on the first minute after the user first sees the solution screen.

User 5 firstly noticed the purple area containing the figure of the solution. He then looked at the orange question area before scanning almost the entire page very quickly including the purple, red, orange, and green areas.

He also looked at the answer area and the Brainpower logo.

User 5 then referred to the task sheet for 10 seconds before looking mostly back and forth between the purple area and the orange area.

Using eye-tracking, the following recordings of the orientation phase are available:

- a focus map highlighting the areas where the user focused their gaze (see below)
- a scan-path movie showing the sequence of fixations (see DVD)
- a gaze movie showing the gaze position (see DVD)

Please see the focus and heat maps below for the areas that have been examined and ignored during orientation phase.

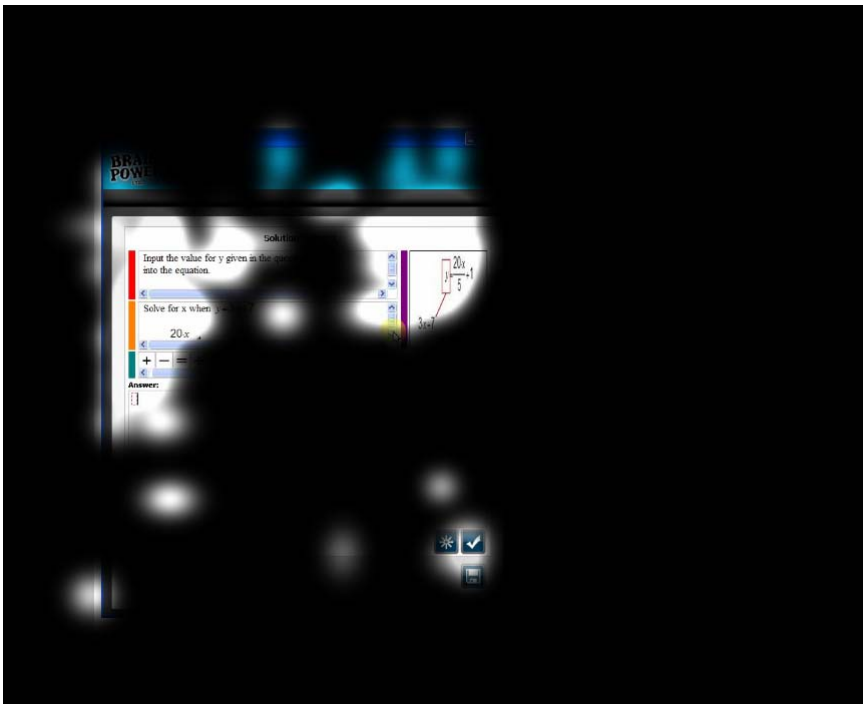

Figure 6: User 5 focus map of the solution screen (The white area shows the area looked at during this time, the black represents the area the user ignored)

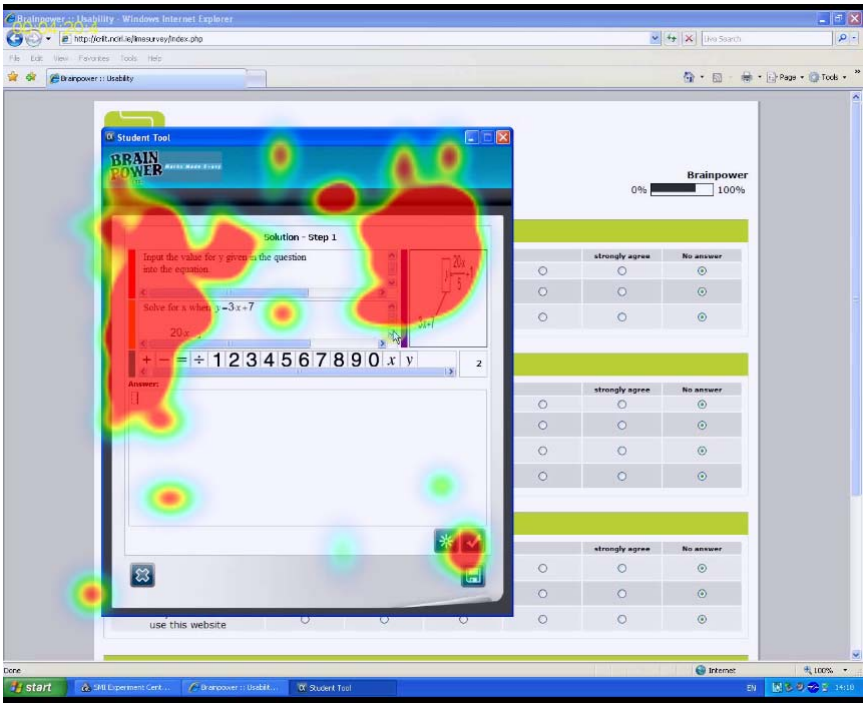

Figure 7: User 5 heat map of the solution screen (The coloured areas signify parts of the screen which were focused on most)

Observations – User 5

TASKS (User 5)	Time (secs)	Errors	Observer comments	Post interview, user	Success
Task 1: Question selection	36	1	Failed to select the paper first.	*If I saw this page I wouldn't think there was anything to click!*	2
Task 2: Question 1	913	6	Fails to see the solutions provided. Problem deleting brackets. Confusion manipulating the division sign. Does not press save. Tester intervention needed.	*Brackets came in when I was highlighting I'm not sure why they came in!*	5
Task 3: Question 2	593	4	Difficulty manipulating the exponent sign. Problem deleting brackets. Tester intervention needed.		5
Task 4: Question 3	208	-	Speeds through this once the answer sheet print out is provided.		1

Success Rating

1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

Post Test Interview

Area	User 5
How to Guide	He said he wished he had flicked to the back first to read about using the input controls, if he had have seen it at the beginning it would have been useful. He suggests instead of having a how to guide to have pop up hints if you are having trouble.
Mathematical Tools	He ran into difficulty manipulating the division sign and the exponent sign. He had a problem deleting the brackets also and tester intervention was needed with this.
Question Structure	He didn't know that he had to add a step for each part of the question. He wished that the application would allow you to answer the question in different ways: *It should be a little less picky in what it accepts* He was not aware that you had to press save after each step.
Design / Navigation	*It's kinda basic, a big white screen with "windows paint" colors thrown in!* *It doesn't look professional!* *I don't know why there is scrollbars, it just sticks out!* On the Solution button: *I kept thinking that that was an add a step button as it a stairs*
Satisfaction	*The principle I like but the actual application needs to improve.* *I found it difficult to use in the beginning, it seemed quite picky about what I was clicking. I don't think it's completely user friendly.* If using it at home he would have found it quite frustrating and may have given up.

Post-test usability Survey Summary

Usefulness	**58%**
This website meets my needs	3
It does everything I would expect it to do	4
This website allows me to do the things I want to do	3
Ease of Use	**50%**
It is easy to use this website	3
It is easy to find what I am looking for	2
The structure of this website is logical and easy to follow	3
If I make a mistake, I can find my way again easily	4
Learnability	**75%**
It is easy to learn how to use this website	4
I learned how to use this website quickly	3
I can easily remember how to use this website	5
Satisfaction	**50%**
I like this website	3
This website works the way that I want it to work	3
This website annoys me	4
I like how this website looks	4
I would recommend this website to a friend/colleague	3
e-Learning	**59%**
I found the content relevant to my needs	4
I found the content at the right level for me	4
The structure was presented in a clear way	3
Feedback on activities was presented in useful way	4
I found in possible to progress through this resource on my own	2
I found this tool fun, engaging	2
I found it easy to see my progress through this course	4
I can adapt this course to my own needs	4
Total	**59%**

5 Usability of Brainpower Application

In this section we will summarise the behaviour of all five users and comment on usability aspects of the Brain Power resource as a whole.

The table below summarises user behaviour across sub-tasks again.

5.1 Summary of Task Completion per User

Task	Time (median)	# of errors	Task Success for User					Comment
			1	2	3	4	5	
Task 1: Question selection	94	5	2	2	2	2	2	All users tried to start the test before selecting a paper first
Task 2: Question 1	913	35	5	5	5	5	5	All users required tester intervention to complete the task
Task 3: Question 2	588	11	5	2	5	5	5	4 out of 5 users required tester intervention to complete the task
Task 4: Question 3	285	5	2	5	5	5	1	3 out of 5 users required tester intervention to complete the task

Success Rating
1 = task completed and efficient;
2 = task completed but with hesitation;
3 = task completed with alternative route;
4 = task completed after error recovery;
5 = task incomplete or learner required intervention

5.2 Usability Attributes of Brainpower

What is Usability?

The term Usability describes the ease with which people can employ a particular tool or other human-made object in order to achieve a particular goal (Nielsen, 2001). While the term is mainly used in the context of software products and websites, the principles of usability may be applied to almost any everyday object that is used by humans.

The primary goals of usability include:

- To make the product more efficient to use: it takes less time to accomplish a particular task.
- To make the product easier to learn: operation can be learned by observing the object.

- To make the product more satisfying to use.

With software products step by step penetrating our daily lives, more and more companies and organisations recognise the importance and the benefits of researching and developing their products with user-oriented instead of technology-oriented methods.

Observing and interviewing users can provide valuable feedback to developers and designers. Usability studies may identify required functionality or design flaws.

While opinions on the different factors that make up usability vary slightly, in most of our projects in NELL we look at the following dimension:

- Usefulness: Does the product support the tasks and activities the user wants and needs to do?
- Ease of Use: How easy is the product to use?
- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Satisfaction: How pleasant is it to use the design, would users recommend to a friend?
- E-Learning: As most of our projects are concerned with on-line learning, we include this dimension which describes the quality of the learning experience.

Usability and Brainpower

In this section we analyse the usability of the Brainpower application. The analysis is based on the quantitative data from the post questionnaire as well as on comments given by the users in the debriefing interviews.

We developed a questionnaire with 15 items referring to the scales Usefulness, Ease of Use, Learnability and Satisfaction and another eight items referring to e-Learning. Scores for each item range from strongly disagree (1) to strongly agree (5). The scale score indicates the percentage of the maximum possible score per

user. The total score indicates the average of all scales (i.e., all scales are weighted equally).

Summary table of how users rated usability attributes of Brainpower:

	User 1	User 2	User 3	User 4	User 5
Usefulness	**67%**	**75%**	**58%**	**75%**	**58%**
This website meets my needs	3	4	3	5	3
It does everything I would expect it to do	3	5	4	4	4
This website allows me to do the things I want to do	5	3	3	3	3
Ease of Use	**19%**	**31%**	**50%**	**88%**	**50%**
It is easy to use this website	1	2	2	4	3
It is easy to find what I am looking for	1	3	4	5	2
The structure of this website is logical and easy to follow	1	2	3	5	3
If I make a mistake, I can find my way again easily	4	2	3	4	4
Learnability	**33%**	**67%**	**33%**	**92%**	**75%**
It is easy to learn how to use this website	1	5	2	5	4
I learned how to use this website quickly	1	2	2	4	3
I can easily remember how to use this website	5	4	3	5	5
Satisfaction	**50%**	**65%**	**35%**	**90%**	**50%**
I like this website	3	4	2	4	3
This website works the way that I want it to work	3	3	2	4	3
This website annoys me	5	2	4	1	4
I like how this website looks	5	3	4	5	4
I would recommend this website to a friend/colleague	3	4	2	5	3
e-Learning	**38%**	**63%**	**44%**	**91%**	**59%**
I found the content relevant to my needs	5	4	4	4	4
I found the content at the right level for me	5	3	3	5	4
The structure was presented in a clear way	3	2	2	5	3
Feedback on activities was presented in useful way	3	4	2	5	4
I found it possible to progress through this resource on my own	1	4	1	3	2
I found this tool fun, engaging	1	3	2	5	2
I found it easy to see my progress through this course	1	4	5	5	4
I can adapt this course to my own needs	1	4	3	5	4
Total	**41%**	**60%**	**44%**	**87%**	**59%**

These usability aspects will be discussed in more detail in the next section on suggested areas for future development.

6 Areas of Future Development

In the final section, we discuss the main issues that emerged during usability testing of the Brainpower application and highlight areas for future development.

6.1 Summary of Observations

	User 1	User 2	User 3	User 4	User 5
Select a paper	Tried to start the test before selecting the paper eventually succeeded.	Tried to start the test before selecting the paper eventually succeeded.	Tried to start the test before selecting the paper eventually succeeded.	Tried to start the test before selecting the paper eventually succeeded.	Tried to start the test before selecting the paper eventually succeeded.
How to Guide	Very useful and kept to the point.	Very useful	Said it could have been more detailed, had to re-read many times to understand	Very helpful said would have been lost without it	Useful but would prefer pop up hints rather than a guide
Mathematical Tools	Difficulty deleting brackets and manipulating the square root and fraction symbols, tester intervention was needed	Difficulty deleting brackets and manipulating the square root symbol, tester intervention was needed	Difficulty deleting brackets and manipulating the division and fraction symbols, tester intervention was needed	Difficulty deleting brackets and manipulating the division/square root/fraction symbols, tester intervention was needed	Difficulty deleting brackets and manipulating the division/exponent symbol, tester intervention was needed
Question Structure	Disliked that the system only accepted one way of answering the question, question description was too vague	Failed to see the question came in steps, failed to press save, tester intervention was needed.	Failed to see the question came in steps failed to press save, tester intervention was needed.	Disliked that the system only accepted one way of answering the question, failed to press save, tester intervention was needed.	Disliked that the system only accepted one way of answering the question, failed to press save, tester intervention was needed.
Design/ Navigation	Found the solutions box difficult to see	Suggested calling the papers simpler names. Confusion over button symbols.	Difficult to navigate, disliked the design.	Liked the design. No confusion over button symbols. Suggested a scribble box would be good.	Strongly disliked the design.
Satisfaction	Liked the hints, disliked the limitations of only one way of answering question.	Difficult to work with. Would like more information when judged incorrectly	Would like more detailed direction, would not use for personal use.	Liked the hints, disliked the limitations of only one way of answering question.	Not user friendly, found it very frustrating.

6.2 Areas of Development

Selecting a paper

All five users failed to realise that they had to select a paper first before pressing the test button; this prompted them with an error message. They all succeeded eventually after randomly pressing various options in order to find it.

How to Guide

The majority of students expressed the usefulness in having a how to guide only one student commented that he would prefer an onscreen version in the format of pop up hints. One student said the guide was brief and to the point if any longer she would have lost interest while one of the students would like to see more detailed information given. It was quite apparent on viewing the observations that each student constantly referred to the guide throughout the test.

Mathematical Tools

All of the students expressed difficulty in manipulating certain symbols ie: fraction/division/square root. They were unsure of what part of the formula to select in order to add the symbol in the correct place. A common error that occurred when they went to add the + symbol was if the entire formula was selected and then they pressed spacebar this would add brackets to the ends of the formula, they could see no way of getting rid of the brackets unless they deleted the entire formula and retyped it again, this caused frustration and tester intervention was needed to get them through this part of the exam.

Question Structure

The system only accepts one way of inputting the correct answer when in reality there is more than one way of solving the same equation. This was not immediately obvious to three of the students and they attempted to try out their own versions of the correct answer. They found it frustrating when they were judged incorrectly when they knew in actual fact that they were correct. The tester had to intervene when this happened and point them in the right direction.

One other common issue arose around the fact that the questions were broken up into steps, two of the students failed to realise that they had to select the add a step button to proceed to the next part of the question they presumed that they could type each formula on a separate line one underneath the next it was quite frustrating for them when they were judged incorrectly on this also. Pressing save was something that was missed by the majority of students they failed to realise that they had to press save after they were judged to allow them to progress to the next part of the question, tester intervention was needed to explain this. One of the students commented on the fact that the question explanation was quite vague it would be helpful if it was more descriptive.

Design and Navigation

Two of the students disliked the look and feel of the design they felt it could look more professional with student five giving some quite specific problems that he found regarding the layout. One of the students found the solutions box difficult to see unless it was expanded. Two of the students admitted confusion over the button icons they weren't sure what they represented.

6.3 Usability attributes

Usefulness

In the table on page 38, two users rated the web site with an average rating of 58% while two of the users rated it in the higher bracket of 75% the remaining user rated it's usefulness as 67%

The majority of users expressed in the post-interview that they would welcome this type of application and on-line support if it was presented in a different way and was easier to use.

Ease of Use

All users expressed at interview stage that they had difficulty in using the application so it is quite surprising that in the on-line survey, one of the users graded its ease of use as 88%.

Two of the users gave very low percentages of 19% and 31% while the remaining two users had average ratings of 50%.

Observations show that all users struggled to use the application successfully during testing (even after some were shown how to use certain aspects). This may have implications for development of How to Guide and training associated with application.

Learnability

All users agreed that they found the site difficult to use at first but once they had completed the first question after tester intervention, they were able to complete subsequent tasks much quicker.

Two users gave a below average rating of 33% while the remaining three gave higher ratings of 67%, 75% and 92%.

Satisfaction

The overall consensus amongst the students appeared to be that the programme was not particularly easy to use and caused some frustration. If they were using the tool at home (and the tester was not there to intervene), the likelihood is that they would have given up. However, they did like the principle behind the tool and could see themselves using it if it was not so difficult to use.

e-Learning

In the on-line survey, two users gave below average ratings of 41% and 44% while the remaining users graded e-learning at 59%, 60% and 87%. Students agreed content was at the right level for them (pass level maths at leaving certificate), but found it difficult to manipulate the application to their own needs and found presentation rigid.

Appendix 1: Questionnaire

Brainpower

Privacy

*** A Note On Privacy**

The data collected through this questionnaire is anonymous. The record kept of your questionnaire responses does not contain any identifying information about you unless a specific question in the questionnaire has asked for this. In this study we may record additional data such as video footage, screen recordings or audio data. While we aim to take all measures necessary to keep this data anonymous, publications or reports to clients may contain samples of this data (e.g., pictures, videos or audio sequences). By participating in this study, you agree that such data may be published and reported.

Do you agree with this policy?

Please choose *only one* of the following:

- ☐ Yes
- ☐ No

What will happen today?

During this session, we will ask you to do three things:

1. Answer some questions about yourself, your background and your experience with computers
2. Go to the Brainpower student tool and undertake 3 maths questions
3. Answer some more questions of what you thought about this resource

If you get stuck or need any help, please just call for help.

Please remember, we are testing the system, not your maths ability!*

Introduction

Participant ID

Please enter Tester number (will be on sheet in front of you)

Please write your answer here:

*** Are you ...**

Please choose *only one* of the following:

- ☐ male
- ☐ female

*** How old are you?**

Please choose *only one* of the following:

- ☐ 16 or under
- ☐ 17-32
- ☐ 33-48
- ☐ 49-64
- ☐ 65 or over

What is your highest level of education?

Please choose *only one* of the following:

- ☐ Primary

- Junior Cert or equivalent
- Leaving Cert or equivalent
- trade or professional qualification
- College or University Degree
- Currently studying for Degree

General Computer Use

*** How often do you use computers?**

Please choose *only one* of the following:

- Daily
- Weekly
- Monthly
- Couple times a year
- Never

What type of computer devices do you use?

Please choose the appropriate response for each item:

	Never	Sometimes	Always
Desktop computer			
Laptop			
Mobile phone (without internet)			
Mobile phone/device (with internet)			
mp3 player/ipod			

What do you use your computer for?

Please choose the appropriate response for each item:

	Never	Sometimes	Always
Office packages such as word, excel etc			
Email			
Web surfing			
Chatting via facebook, bebo, twitter etc.			
On-line shopping			
Games			
Skpe			
E-learning			

What kind of Internet connection do you have at home?

Please choose *only one* of the following:

- Dial-up
- High Speed
- Broadband

Maths support

What year did you undertake your leaving certificate?

Please write your answer here:

*** What level of maths did you undertake in the Leaving Cert.? Ordinary or Higher level maths?**

Please choose *only one* of the following:

- ☐ Ordinary level
- ☐ Higher level

When you were studying maths for the Leaving Cert. what maths supports did you use? e.g grinds,past papers, on-line support.

Please write your answer here:

Do you use any maths support resources/materials in your current studies? If so, which resources do you use?

Please write your answer here:

Activitiy

We would like you to imagine the following scenario.
You are currently a 6th year (or repeat) student who is studying for Ordinary level maths in the Leaving Certificate. Your class teacher has explained that she has used a new on-line application to create 3 sample maths exam questions and emailed them to you.
She has asked you to download the Brainpower application, and attempt the three questions.
Now open the application, read the 'How to' guide and attempt the three questions.

Usability

How Useful is this resource?

Please choose the appropriate response for each item:

	strongly disagree				strongly agree
This website meets my needs	☐	☐	☐	☐	☐
It does everything I would expect it to do	☐	☐	☐	☐	☐
This resource allows me to do the things I want to do	☐	☐	☐	☐	☐

How Easy to use is this resource?

Please choose the appropriate response for each item:

	strongly disagree				strongly agree
It is easy to use this tool	☐	☐	☐	☐	☐
It is easy to find what I am looking for	☐	☐	☐	☐	☐
The structure of this website is logical and easy to follow	☐	☐	☐	☐	☐
If I make a mistake, I can find my way again easily	☐	☐	☐	☐	☐

Is this tool easy to Learn?

Please choose the appropriate response for each item:

	strongly disagree				strongly agree
It is easy to learn how to use this website	☐	☐	☐	☐	☐
I learned who to use this website quickly	☐	☐	☐	☐	☐
I can easily remember how to use this website	☐	☐	☐	☐	☐

How Satisfied are you with this resource?

Please choose the appropriate response for each item:

	strongly disagree				strongly agree
I like this tool	☐	☐	☐	☐	☐
This website works the way that I want it to work	☐	☐	☐	☐	☐
This resource annoys me	☐	☐	☐	☐	☐
I like how this website looks	☐	☐	☐	☐	☐
I would recommend this resource to a friend/colleauge	☐	☐	☐	☐	☐

E-Learning

Please let us know what you think of this learning resource

Please choose the appropriate response for each item:

	strongly disagree				strongly agree
I found the content relevant to my needs	☐	☐	☐	☐	☐
I found the content at the right level for me	☐	☐	☐	☐	☐
The structure was presented in a clear way	☐	☐	☐	☐	☐
Feedback on activities was presented in useful way	☐	☐	☐	☐	☐
I found it possible to progress through this learning resource on my own	☐	☐	☐	☐	☐
I found this learning resource fun, engaging	☐	☐	☐	☐	☐

I found it easy to see my progress through this learning resource	☐	☐	☐	☐	☐
I can adapt this learning resource to my own needs	☐	☐	☐	☐	☐

Feedback (Final Section)

What did you like most about this resource?

Please write your answer here:

What did you dislike most about this resource?

Please write your answer here:

How could this resource be improved?

Please write your answer here:

Submit Your Survey.

Thank you for completing this survey..

Appendix 2: User Instructions

ID: TESTER 5

Scenario:

We would like you to imagine the following scenario. You are currently a 6th year (or repeat) student who is studying for Ordinary level maths in the Leaving Certificate. Your class teacher has explained that she has used a new on-line application to create 3 sample maths exam questions and emailed them to you. She has asked you to download the Brainpower application, and attempt the three questions. Now open application, read the 'How to' guide and attempt the three questions.

Activity 1

Please have a look through the 'How to Guide' in front of you.

Activity 2

Please open the brainpower application, select file C://sharedocuments&settings….

Attempt three maths questions.

Good Luck!