

# **Solve For X where X = Learned Helplessness**

Using technology to overcome the fear of learning mathematics for the adult learner

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## **Declaration**

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

Signed: \_\_\_\_\_  
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*“Belief gets in the way of learning”*

- Robert Heinlein

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## **Abstract**

Learned Helplessness (LH) and Helpless Attributional Style (HAS) are phenomena identified by Seligman (Staffon, Ettinger, 1989) to explain why animals and subsequently humans submit to pain and torture rather than actively escaping them. Within the educational sphere, LH and HAS have been proposed as explanations for attitudes of certain groups towards the acquisition of new knowledge. Within mathematics, many students have significant difficulty with motivating, understanding or believing in their ability to handle the subject, based upon prior perceived failure with understanding it.

Papert (Papert, 1993) suggests that the use of technology can present a topic to a student using epistemological pluralism, or multiple ways of knowing. He suggests that by creating a collaborative technological environment, which is distanced from a set curriculum, the student can create self-directed learning, which encompasses Papert's theory of 'Hard Fun', where the work is fun because it is hard and does not suggest that the "make it fun, make it easy" approach is taken (Papert 2002). Vygotsky theories of collaboration suggest that students are capable of performing at higher intellectual levels when asked to work in collaborative situations than when asked to work individually (Vygotsky 1978).

This work identifies students with LH and HAS, and unlike many other studies in this area, attempts to offer an alternative way of conceptualising mathematics, so as to overcome these fears. It enables the students to collaborate in the learning experience, and still motivate each other by promoting friendly rivalry and incorporating a fun aspect to learning while developing higher order thinking skills. It removes them from the traditional classroom and provides them with a self-paced, self-directed learning environment.

A group of 38 adult learners participated in the study. They are aged between 23 and 60 and are the Access group in GMIT for the academic year 2004-05. The group are first tested for symptoms of LH and HAS using the Attributional Style Questionnaire, which is an authenticated measure of the existence and severity of LH and HAS. The learners use the learning tool over a four-week period, followed by one-to-one interviews with participants to identify the usefulness of the learning intervention.

The quantitative and qualitative analysis suggests that students with LH and HAS demonstrate definite improvement of symptoms after participating in the study. Students with mild or no symptoms also found the experience to be refreshing and improved their perception of mathematics and their predictions of future performance in maths exams. However, the findings do concur with research suggesting that LH and HAS do not necessarily correlate to poor performance in Mathematics (Houston 1994).

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# **Introduction**

## *Background*

This work originated from the recurring negative attitudes the author encountered when lecturing adults who were returning to education. Access students tend to require psychological as well as educational hand-holding and the lecturer often plays the dual role of counsellor and educator. The Access student who encounters a mathematics lecturer, and who has probably just stepped into a third level institution for the first time in their lives, tend to suffer palpable fear and anxiety. These students are eager to tell their story; to recount the awful experiences of learning mathematics that has haunted them from their youth, which often times was long ago.

In the initial months of the first year of this masters program, the concept of learned helplessness arose. This simple idea has led to a passionate journey of discovery as to how a student who has an extreme anxiety towards learning mathematics can overcome this fear.

## *Thesis Roadmap*

The following section sets out in brief the layout of the entire paper. It gives an overview of the content of each section and acts as a reference guide for the reader.

## **Literature Review**

This section describes what learned helplessness and helpless attributional style are and their original applications. Their application and affect on performance within the educational sphere are explored. As they do not necessarily have a negative affect on performance, both their positive and negative affects are evaluated. There is little research with respect to learned helplessness and helpless attributional style within mathematics education; hence alternative studies into fear and anxiety of mathematics are explored and critically compared with these theories.

Questionnaires to measure learned helplessness and helpless attributional style are evaluated, followed by a critical analysis of how educational theorists ideas and conjectures may be applied to the student who is math phobic due to learned helplessness. An evaluation of how technology, education theories and overcoming fear of mathematics are married towards the end of the literature review.

## Design of the learning experience

Incorporating the progressive thinkers in mathematics education, technology for education and methods for overcoming learned helplessness and helpless attributional style are culminated together to explain and defend the design of this learning experience. The educational principles upon which the design is built, its format, content and architectural overview are discussed.

## Implementation of the learning experience

This section outlines who the participants in this research are and how they were measured and scored for learned helplessness and helpless attributional style. Their exposure to the learning experience is discussed, followed by a second measure of their learning and attitude change.

## Methodology

A defence and justification for the use of action research is included in the methodology. Both quantitative and qualitative evaluation methods are used and this triangulation of methods is defended. The scoring of the questionnaire (called the ASQ) for learned helplessness and helpless attributional style is quite complex and is outlined and reviewed. As it has been peer reviewed and authenticated, its reliability for measuring learned helplessness and helpless attributional style for mathematics students is discussed. The questionnaire created for measuring changes in symptoms upon completion of technological learning experience is explained, critiqued and its limitations outlined.

## Evaluation and key findings

As the ASQ yields masses of data, a system to collate the results within a research project of this scope is outlined. A relative measure of the findings from the post-learning experience questionnaire is given, yielding quantitative and qualitative findings and results. Researcher observations and specific or unusual events are recorded.

## Summary and conclusion

This final section, excepting the appendices and references, concludes the thesis and highlights the most important findings. As reflection is a key factor of action research, the researcher's own path of discovery is reflected upon and forms the basis for the recommendations for future research in this intriguing research area.

# Literature Review

## *Overview*

This review endeavours to navigate the definitions of learned helplessness and helpless attributional style and to outline their applications both outside and within the educational sphere. Alternative theories on fear of learning mathematics, like self-efficacy, affect and Mathophobia are defined and compared with learned helplessness and helpless attributional style. How learned helplessness and helpless attributional style are measured is outlined. Solutions to overcoming these are explored within a framework of the great educational theorists like Papert and Vygotsky. Justification for using technologies for math education are outlined and defended.

## *Learned Helplessness and Helpless Attributional Style*

Learned Helplessness is a term coined by Seligman (Abramson, Seligman & Teasdale, 1978), a behavioural psychologist, to describe his theory that helplessness is a learned state produced by exposure to unpleasant situations from which there is no possibility of escape or avoidance. Seligman's initial trials involved placing a dog in a cage, from which there was no escape. A bell sounded, followed by an inescapable shock. Having repeated this procedure over three days, the door of the cage was opened. Seligman noted that even though an obvious escape route now existed, on hearing the bell the dog braced itself for the shock, rather than flee it. Seligman concluded that there exists a pathological helplessness so extreme that even when an avenue of escape is provided an animal will not take it (Staddon & Ettinger, 1989).

Since these initial trials, the theory of learned helplessness has grown and developed to include explanations for varied negative reactions of not just animals, but also humans to resistive stimuli. Learned helplessness in humans has been defined as an “insidious condition involving undeveloped executive functioning, lack of persistence and an undeveloped sense of connecting new words or concepts

into a web of meanings” (Spence and Stan-Spence, 1990). Learned helplessness has more crucially been described as a tri-faceted phenomenon with a contingency, cognition and behavioural component. Contingency relates to the feeling of uncontrollability of a given situation. Cognition refers to the attributions made with respect to the situation or surroundings. While behaviour relates to the decision to either proceed or give up when presented with an obstacle (Peterson, Maier & Seligman, 1993).

The learned helplessness theory was later reformulated to the theory of helpless attributional style. This theory suggests that an individual's attributional style, which is their general tendency to generate similar causal explanations across events, is useful for explaining why some individuals who are exposed to failure events over time, develop negative psychological symptoms like depression, while others do not (Peterson, Maier & Seligman, 1993). Attributional style can be broken down into one of two types of responses to an aversive event. When the bad event occurs, the individual will ask themselves why this event happened. The nature of their answer sets the parameters for the helplessness that follows. If the individual beholds a causal attribution which is stable (this is going to last forever), global (this is going to undermine everything) and internal (this is all my fault), they are more likely to experience a negative depressive mood reaction than the individual who typically attributes negative outcomes to unstable (this will not last long), specific (this was just a once off) and external factors (the problem was just too hard) (Peterson & Vaidya, 2001).

### *Learned Helplessness and Helpless Attributional Style – non-educational areas of application*

Seligman's theories have formed the basis of many medically related explanations and only in recent times have been applied within the educational sphere. Learned helplessness in the rat has become a valid and well-established model for human clinical depression (Peterson, Maier & Seligman, 1993). This animal model for clinical depression subsequently formed the basis of many drug tests and subsequent human treatments (Kram et al., 2002, Russo-Neustadt et al., 2001).

Learned helplessness studies have been presented as an explanation for post-traumatic stress disorder (PTSD). Periodic ‘reminding’ of the inescapable shock causes the subject to re-experience the helplessness of the original trauma (Maier, 2001). Kashdan et al. (2000) applied the construct to disruptive children, whose mothers experienced high and low levels of social anxiety. Within an experimental setting, mothers with high social anxiety became more distressed with a deviant child than others. The reformulated theory of learned helplessness has been proposed as a model for the emotional numbing and maladaptive passivity that sometimes follows victimization (Peterson & Seligman, 1983). Attributional style has created the basis for measuring behaviour of females who verbally and behaviourally demonstrate dietary constraint (Rotenberg, Carte & Speirs, 2005). Other studies on attributional style include the clinical implications of substance abusers (Garcia et al., 2005).

The sheer breadth of application of the theories of learned helplessness and helpless attributional style are phenomenal. This study however, endeavours to embrace the theories of learned helplessness and helpless attributional style and find their application within the educational sphere, where unlike the clinical, medical and psychological spheres, fewer studies of their existence and effects exist.

### *Self-efficacy, learned helplessness and helpless attributional style within the educational sphere*

Bandura’s (1986) theory of self-efficacy defines how a student will judge their own capability in a given situation. Similar to learned helplessness, with low self-efficacy, the student will determine their own ability and will react with thoughts and emotions that support this self-belief (Hamilton & Ghatala, 1994). Within the educational sphere, many studies have demonstrated that self-efficacy is a predictive measure of academic performance. Andrew’s (1998) tested for self-efficacy with respect to learning science subjects in a study of first year nursing students. Andrew established that a students’ predetermined self-belief have a significant impact on their resulting performance. Another study involving young children starting primary school found that pre-schoolers tended to self-handicap



and have maladaptive achievement strategies, if their cognitive competence was poor (Onatsu-Arvilommi et al., 2002). Self-efficacy is a similar theory to those of this study. While it is more founded in education, it does not encompass the far-reaching depths of Seligman's theories. The concept of an identifiable problem, like learned helplessness or helpless attributional style, being further compartmentalised into contingency, cognition and behavioural components, creates a larger surface area of potential solutions that will empower and equip the student to overcome their effects.

Firmin et al (2004) hypothesized that learned helplessness had a negative effect on test taking. In this study two groups of undergraduate students identified with learned helplessness were tested in alternative manners. The first group were given tests which started with difficult problems, progressing to easier ones, while the second group tests were reversed. The findings suggest that suffers of learned helplessness are more likely to give up and fail to proceed even when the problems become increasingly simpler. Students partaking in research who showed symptoms of helpless attributional style gained lower grade point averages than other students at end of year examinations (Peterson & Barrett, 1987). Peterson and Vaidya (2001) measured attributional style, general expectations for future good and bad events and depressive symptoms in first year psychology students. Their findings confirmed a role between expectations in the hypothesized link between explanatory or attributional style and depression.

However not all research suggests that helpless attributional style has a negative effect on performance. Work by Houston (1994) found in three independent studies that undergraduates with helpless attributional style can be more steely and determined at examinations and hence have superior performance than non-sufferers. Another longitudinal study of college students had findings suggesting that helpless attributional style was unrelated to exam performance in the first half of a semester and positively correlated to improvements in performance in the second semester (Yee et al., 2003). Another non-educational study involving sports persons with helpless attributional style found them to have stronger degrees of mental toughness on the playing field than others (Davies & Zaichkowsky, 1998). Hence in this study, the potential results are by no means pre-determined.

Most studies of learned helplessness and helpless attributional style start by subjecting participants to failure experiences and then measuring performance in a transfer task (Russo-Neustadt et al., 2001, Maier, 2001). Some findings suggest that if the initial failure is modest, then the resulting performance will be enhanced. While if the initial failure is high or low then performance will be reduced, when compared with participants who do not display traits of learned helplessness or helpless attributional style (Mikulincer, 1988). Also much research on learned helplessness and helpless attributional style simply measure them and their effects (Houston, 1994, Firmin et al., 2004). There is an apparent gap in the research in methods to not just measure and observe but overcome these traits. This study is different in that it tests for a predisposition towards either learned helplessness or helpless attributional style prior to an intervention of an alternative pedagogical method, and to address if there is any improvement in the symptoms after the intervention.

### *Fear of Learning Mathematics*

Humans are born with just two fears: the fear of falling and the fear of loud noises. Throughout childhood and into adulthood many more fears manifest themselves. In childhood, expressing fears through play e.g. role-play, make believe play etc., can help a child overcome fear (Tassoni & Bulman, 1999). However most fears manifest themselves in private and then become barriers to further opportunities.

Affect is a major research area into the fear of mathematics learning. McLeod (1992) identified three concepts used in the research of affect in mathematics education. He identified emotion (“I feel afraid/challenged by this problem”) as being the most intense but least stable dimension. The second dimension is beliefs (“there is no way I can solve this problem/I can so solve this problem”), which is considered the least intense and most stable. While attitudes (“why am I even bothering?/I really want to learn”) lie within the extremes of the other two. Subsequent researchers added a fourth dimension to affect – values, which are the choices, priorities and actions that accompany an educational goal (DeBellis & Goldin, 1997). Tobias (1978) suggests that math anxiety manifests itself over the

primary school years, through fear of being too smart or too dumb, failing to question, or from a distrust of one's intuition. Both research areas of affect and math anxiety show proof of gender differences in approaches to learning mathematics. A major study into gender differences in self-concept with respect to mathematics found that women are less confident learners than men (Sax, 1992). A similar study on women's self-schemas in mathematics and science ability had similar findings (Lips, 1984). While the current study does not look specifically at male/female differences, or the theories of affect and math anxiety, acknowledgement of the vast body of research in these areas is noted. For the purpose of this work, it may be reasonable to assume that although different in approach, affect and math anxiety are convergent theoretical notions to learned helplessness and helpless attributional style.

Mathophobia, a concept of Papert's (1993), suggests that mathematics is taught poorly at school, as it is distinctly disassociated from all other learning. Mathematics is taught without any association with other activities, like learning language. Papert suggests that Piaget's life-long studies of how children learn, show that a time is never set aside by a child to learn, or example, 'to talk' and hence applying this 'setting aside' of a specific time for learning mathematics is a poor judgement on behalf of educators. Papert suggests that the schooling system ensures that the individual creates a self-perception that they are either good at humanities or science, and that these are mutually exclusive. The mathophobic believes that they cannot do mathematics and will prevent themselves in doing whatever they recognise as math. This theory draws parallels with those of Seligman (1978), whose additional conjunctures of helplessness forming barriers through motivation, behaviour, contingency and cognition create an even more holistic perspective of the math phobic. It may be reasonable to assume that the solutions proposed by Papert for Mathophobia may also be applied to the current research.

### *Solutions for overcoming fear of learning mathematics*

As stated earlier, learned helplessness is defined as a condition which affects the individual on three levels, namely contingency, cognition and behaviour. Research

in contingency or the uncontrollability of a situation suggests that if an individual is in control of their environment, they are decidedly more likely to out perform those who are not in control (Gernigon et al., 1999, De Saintonge, 1998). As mathematics tends to be taught at specific times and in a tutor controlled environment, there may be little chance for the individual suffering from learned helplessness to take control of their learning.

Cognition relates to the learning situation and surroundings relating to the learning environment. Papert (1993) cautions against mathematics being taught as a disassociated subject, and suggests that by improving the connectivity of many subjects like mathematics and languages, for example, that the learning experience will be enhanced.

The third aspect of learned helplessness is behaviour, or the individuals decision process to either proceed or give up on a challenging task. Motivation plays a part in a learner's self-belief and behaviour. A study examining psychological processes as predictors of success in college suggested that the students' confidence in their own intelligence had major implications for academic success (Livengood, 1992). While that study was carried out to establish a possible explanation for poor student retention, parallels can be drawn between it and the learner who gives up due to learned helplessness and helpless attributional style. Gardner's (1989) theory of multiple intelligences, suggests that logical-mathematical intelligence is almost 'hard-wired' into the individual, as it is part of a 'raw intellect'. However, individuals suffering from learned helplessness will often give up on a task long before they have reached the boundaries of their logical-mathematical intelligence. By introducing an alternative learning environment, this study hopes to challenge the helpless student to look beyond their current contingency, cognition and behaviour and challenge their actual logical-mathematical intelligence, as defined by Gardner (1989).

## *Measuring learned helplessness and helpless attributional style*

The attributional style questionnaire (ASQ) (Peterson, Semmel, von Baeyer, Abramson, Metalsky, Seligman, 1982) is a self-report measure of patterns of 'explanatory style' (Peterson & Seligman, 1984), which is the tendency to select certain explanations for good and bad events. The revised model for learned helplessness and helpless attributional style states that when faced with an uncontrollable bad event, a person will wonder why the event occurred. The model suggests that a person's answer to this question will help to determine their adaptation to the event. Abramson et al. (1978) content that there are three dimensions relevant to a person's casual attributions and that each dimension is associated with a particular aspect of adaptation to an uncontrollable event.

The first dimension is the locus of one's casual explanation: Did this event occur because of something about me (an internal attribution), or something about the situation (an external attribution)? The model predicts that internal attributions for bad events are associated with a subsequent loss of self-esteem. The second dimension is the stability of the casual explanation: Did the event occur because of something that will persist (a stable attribution) or something that is transient (an unstable attribution)? The model predicts that stable attributions lead to more chronic adaptation deficits following exposure to an uncontrollable bad event (Peterson et al., 1982). Finally, the model considers the globality of the casual explanation: Will the cause of this event influence many aspects of life (a global explanation) or influence only the currently experienced event? The globality of a person's casual explanation is thought to predict the generality of adaptation deficits across situations. Attributing the bad event to a global factor will lead to pervasive adaptation deficits, whereas attributing the event to a more specific cause will lead to less pervasive deficits (Peterson et al., 1982).

Using this conceptual framework, Seligman et al. (1984) developed the ASQ. To measure attributional style rather than an explanation for a particular event, the questionnaire describes twelve hypothetical events. Half of the events described are good and half are bad. These events are presented in booklet format and are

despatched to the individual with brief and simple instructions (Appendix 2). They ask respondents to imagine that they are in the situations described. For each situation, the respondent writes a cause of the event. After writing down the cause of the event, the respondent is asked to rate on three seven-point scales 1) whether the outcome was due to something about them or something about other people or circumstances (locus) 2) will the cause again be present? (stability), and 3) does the cause influence just this situation or other areas of their life (globality). Respondents circle one number from one to seven corresponding to their causal beliefs. The scales are anchored so that external, unstable and specific attributions receive lower scores, whereas internal, stable and global attributions receive higher scores.

### *Vygotsky and Papert and alternative ways of knowing*

Vygotsky's (1978) concept of collaborative learning, which involves the grouping and pairing of students for the purpose of achieving an academic goal, has been widely researched and advocated throughout the professional literature. The term "collaborative learning" refers to an instruction method in which students at various performance levels work together in groups toward a common goal. The shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Totten et al., 1991). Within this synergy environment, the teacher acts as facilitator, a constructionist philosophy which promotes teaching in such a way as to produce the most learning for the least teaching (Papert, 1993). Traditionally mathematics was taught using an instructionism philosophy, whereby improving the level of instruction creates better learning. Challenging this idea, by creating the incentive to learn independently, but within a supportive framework may prove to be the prescriptive remedy for overcoming learned helplessness and helpless attributional style.

Papert (1993) suggests that the art of learning has been widely overlooked by educational researchers and practitioners. His Mathetics theory for using computers for flexible, personal and connected learning appeals here. Unlike some advocates of collaborative learning for mathematics like Smith (1998), Papert

suggests that the student should work at their specific pace and have time to relax with a problem, so as to improve their abilities and create real learning. This latter theory would also support the original definition of learned helplessness, which referred to the uncontrollability of the helpless environment (Seligman, 1978). Learners are often in uncontrollable situations when they are allegedly gaining knowledge. By altering the environment and pace, students who previously felt daunted, may well excel. By cherry picking the discussion and critical thinking aspects of collaborative learning and marrying them with use of technologies and epistemological pluralism, a real solution for learned helplessness and helpless attributional style may occur by improving the connectivity in the learning environment.

### *Mathophobia and Hard Fun*

As stated earlier, Papert (1993) suggested that Mathophobia creates taboos about learning which are deeply engrained in the adult, and are usually a throw-back from a negative learning experience in childhood. An individual believe themselves to be 'dumb' at a subject (often mathematics) and only some exceptional event will lead them to reorganise their intellectual self-image so as to open new perspectives on what they can really learn. Papert (1993) cautions against the science of aptitudes and their apparent measurability. He suggests that the current rigid limitations of curricula and examinations are outdated and inherently flawed. Papert's analogies for teaching dance by drawing dance steps on square paper, without intervention of music or a dance floor, epitomises what he suggests is wrong with a mathematics curriculum, which insists on hours spent 'doing sums', which hold little or no meaning for the learner.

The predominant educational culture of the western world reflects a method of teaching mathematics via just one route, namely the 'chalk and talk' model. With this model, learners are given scarce resources for making sense of what they are learning. Papert suggests a new approach to learning, involving entering into mathematical conversations, solving real life examples and using the computer as a

tool for such learning. While cautioning against the culture of ‘making math easy’, Papert suggests that learning mathematics should be fun – hard fun.

Hard fun was a phrase used by a young boy who partook in a LEGO programming experiment conducted by Papert. The boy became totally adsorbed in the procedure and was learning lots of trial and error program debugging. Papert realised that the mathematics student becomes too obsessed with gaining the correct answer, while the computer science student, assumes that their first and several subsequent attempts will require rework (Papert 1999, 2002). The boy described the programming work as being fun and hard. Papert suggests that the boy meant the work was fun because it was hard, rather than in spite of being hard.

Mason (2004) suggests that students should be given the opportunity to construct their own mathematical examples, which he suggests, encourages active learning, creates anticipation and invites conjecture. These educational principles form the basis for the technological artefact of this study, which endeavours to help the reluctant learner overcome symptoms of learned helplessness and helpless attributional style, by applying progressive educational research to the old model of learning mathematics.

### *Technology and Math Education*

Epistemological pluralism or multiple ways of knowing is a theory of Pigaet, later modified by Papert to include technologies for knowledge acquisition (1993). As a firm advocate of the use of computers for alternative learning, Papert suggests that creating an environment for the learner, where they can work at their own pace and without the constraints of the classical mathematics classroom will enhance their motivation and self-belief.

The use of computers in mathematics education has recently become an alternative and acceptable pedagogical method for the forward thinking educator (Shaw et al., 1997, Tanner, 1992, Crowe & Zand, 1997). With the emergence of distance and open learning, modularisation and flexible learning at third level, the use of web based learning and the computer as tutor is becoming increasingly main-stream.



The technology created for this research endeavours to be further reaching. If learned helplessness and helpless attributional style is to be countered *and* mathematical performance enhanced, this software must add some dimension of instant response, immediate feedback and create a positive learning outcome when encountered by the student. Tobais (1978) suggests that even the capable mathematician, when faced with a math problem, flounders for a period of indeterminate length. How well one sticks with the problem through this floundering may well be a function of ones tolerance of floundering in general. As the helpless student has a tendency to give up, positive interaction with the technology, by way of hints or encouragement is critical. In support of Papert and Mason's perspective on the content of mathematics teaching interventions, use of the technology in this study is self-paced and allows the user to create their own examples and challenge their own learning and that of others, through a mathematical discussion forum. While definite timeframes for its use with a tutor present will exist, students may access the software at their convenience, working at their own pace in a personal and flexible mode.

Salomon (1992) describes three types of approaches to educational computing: computer-aided instruction or intelligent tutoring systems, programming and cognitive tools. These cognitive tools include software that are model builders, data sets affording manipulation, conceptual map makers, simulations and open-ended instruments affording user interaction and manipulation. Salomon claims that cognitive tools are the most hopeful route to the successful use of computers in education. Educational software should be designed so as to facilitate problem-solving, allow user interaction and create alternative perspectives (Smith, 1999). This artefact aims to empower the reluctant learner by allowing user participation, conjecture and encouragement for the acquisition of knowledge of mathematics.

## *Conclusion*

A culmination of the findings of this literature review resulted in the thought process that creates the basis for the design of the learning experience explained in the next section. The tri-faceted marriage between overcoming the negative impact of learned helplessness and helpless attributional style with solid educational

principles and within a technological learning environment poses an exciting challenge for this researcher.

# Design of the Learning Experience

## *Overview*

This chapter outlines the educational principles used to design the learning experience. An overview of the types of mathematical scenarios used in the artefact are outlined and justified. An architectural overview of the artefact is presented, followed by a brief description of the support system and programming languages. Finally the main functionalities of the artefact are presented.

## *Educational Principles*

This learning experience aims to incorporate several educational principles in order to overcome learned helplessness and helpless attributional style as encountered in mathematics education. These principles have been adopted as a result of research in the area of best practice in education, learning and treatable symptoms of learned helplessness and helpless attributional style.

The educational principles incorporated in the design of this artefact include:

1. Collaborative learning
2. Hard Fun
3. Self-directed and self-paced learning
4. Humanistic and humane presentation of mathematics
5. Distance of work from the curriculum
6. Improved motivation

## Collaborative learning

By adopting Vygotsky's (1978) theories that learners in groups will peer motivate and create a positive synergy, this artefact allows for remote interaction between students. The educational purpose is to improve the learners' thought process, broaden the learning experience and allow them to create mathematical problems from their own knowledge, which they will share with the group. Friendly rivalry

and helping each other with hints and a discussion forum will be actively encouraged.

## Hard fun

The artefact incorporates Papert's (2002) theory of fun – hard fun. Some of the questions are farcical and offer an opportunity for the learner to engage with the learning experience in a non-oppressive way and hence attempt to have them relax and enjoy the experience. It is envisaged however that the learner will not find all of the content easy, but will be challenged and 'drawn in' to the alternative pedagogical methodologies. It is hoped that the artefact will encourage learners to create their own questions, invite conjecture and will help the learner to become adsorbed with mathematical scenarios.

## Self-directed & self-paced learning

The individual suffering from learned helplessness or helpless attributional style often feel that they have no control over their environment. After an initial demonstration by the tutor, this artefact will be available to students working at a time that suits them. They will take responsibility for spending time working at the mathematical scenarios presented and entering problems of their own making. As the time a student spends working on any particular problem is not being measured, it is envisaged that the learner will take the time to relax with the problems and allow themselves to become immersed in the alternative learning environment. This will broaden the perspective of mathematics of a subject taught only by 'chalk and talk' and will empower the learner to be in charge of their knowledge acquisition.

## Humanistic & humane presentation of mathematics

In the classroom, mathematics tends to be taught in isolation, with hours of doing 'sums' without any relevant application. This learning experience offers mathematical scenarios that are worded and practical. It is hoped that the learner

will be able to relate to these is a way not often encountered in the conventional classroom. It is envisaged that by making the problems not really ‘look like’ mathematics, that the student may use epistemological pluralism or multiple ways of knowing. By applying some of the principles of the humanities vis-à-vis wording problems and by creating an alternative way of conceptualising mathematics, it is proposed that the symptoms of learned helplessness and helpless attributional style may be alleviated.

## Distance from the curriculum

Another fun aspect of this artefact is the non-existence of conventional examinations and the visual reward of a tree part for each correct answer. It is envisaged that students will converse with each other about the ‘shape’ of their tree, which will signify their relative strengths and success in a particular topic. While the questions posed within topics are worded and mostly have a real-life dimension, they also build on the knowledge gained in the conventional classroom, without becoming overly obsessed with the syllabus content.

## Improved motivation

As the artefact is learner initiated, does not involve graded examinations, does not really ‘look like’ mathematics and endeavours to be fun, it is hoped that the motivation of the student for the acquisition of mathematical knowledge will improve. If motivation is improved and learned helplessness and helpless attributional style overcome, transfer of these advantageous outcomes should apply to the conventional mathematics classroom

## *Topics and questions*

The topics and questions within them are broken into five distinct sections. The database is created so that expansion of either is a relatively simple administrative task. The topics loosely follow the Access syllabus, but are named so as not to look like perceived difficult mathematics. Unlike most classroom examples, the questions are all worded, allowing the learner to engage with their learning and

think on a different level than would be required if the student were simply ‘following the steps of the teachers example’. The questions were taken from books by Huettenmueller (2003), Gardner (1988, 1994) or created by the researcher. Learners are encouraged to construct their own questions and there is an open invitation for conjecture. Learners will gain feedback from peers on the questions set, and offer feedback to classmates who attempt their created problems. This provides a collaborative learning and fun environment. The questions set by the tutor are not all easy, but rather endeavour to create a safe environment for the student, which is initiated and controlled by them, and promotes the positive features of Hard Fun.

### *Architectural overview*

The artefact has been designed using a multi-user client/server architecture model. It uses a MySQL Database Server to store the information about the users, the questions and the progress of the users. The system is implemented as a web site, providing easy access, minimal client installation of software and allows for greater accessibility. Appendix 4 shows an overview of the system structure.

### **Client/Server model**

Client/Server systems allow for the users to access the system without having to install software on their own computers. This makes it easier for the non-technical learner to use the software. Client/Server is suited to a web-based interface, which can be hosted on any server and accessed from any machine throughout the campus. As PC Labs often have restrictions on the number of students using machines and the times of access, this system empowers the student for self-directed and self-paced learning.

### **Database system**

Any system with multiple users and restricted access will have to store some information about these users. Also, the question bank has to be organised and the information easily accessed. This is best achieved by employing a Database

Management System (DBMS). In this study, MySQL was deemed to be the best option, because it is free for educational use, has good authentication, is easy to use with a scripting language embedded in HTML and provides a scalable system for multiple users.

## Programming language

The primary language used in this system is Hypertext Mark-up Language (HTML). HTML is an Internet protocol designed for the rapid distribution of Hypertext Documents. HTML is used for static documents. In order to access the database and provide the dynamic content for the web pages in this artefact, a scripting language called PHP has been used. PHP is used in preference to JavaScript or other scripting languages because it has a shorter learning curve, it is easier to set up, and it provides the required functionality for this artefact.

PHP generates the web pages and these are then presented as static content to the user. Anybody viewing the source of the web pages will not see the PHP code, but the generated HTML code and this in turn provides a layer of security for the web site.

## Apache web server

Apache web server is a free web server available for download from <http://www.apache.org>. It is easily installed, stable and PHP integration is easy to achieve. The web server can be installed in a development or production environment and as such was an ideal choice for this artefact.

## *System functionality*

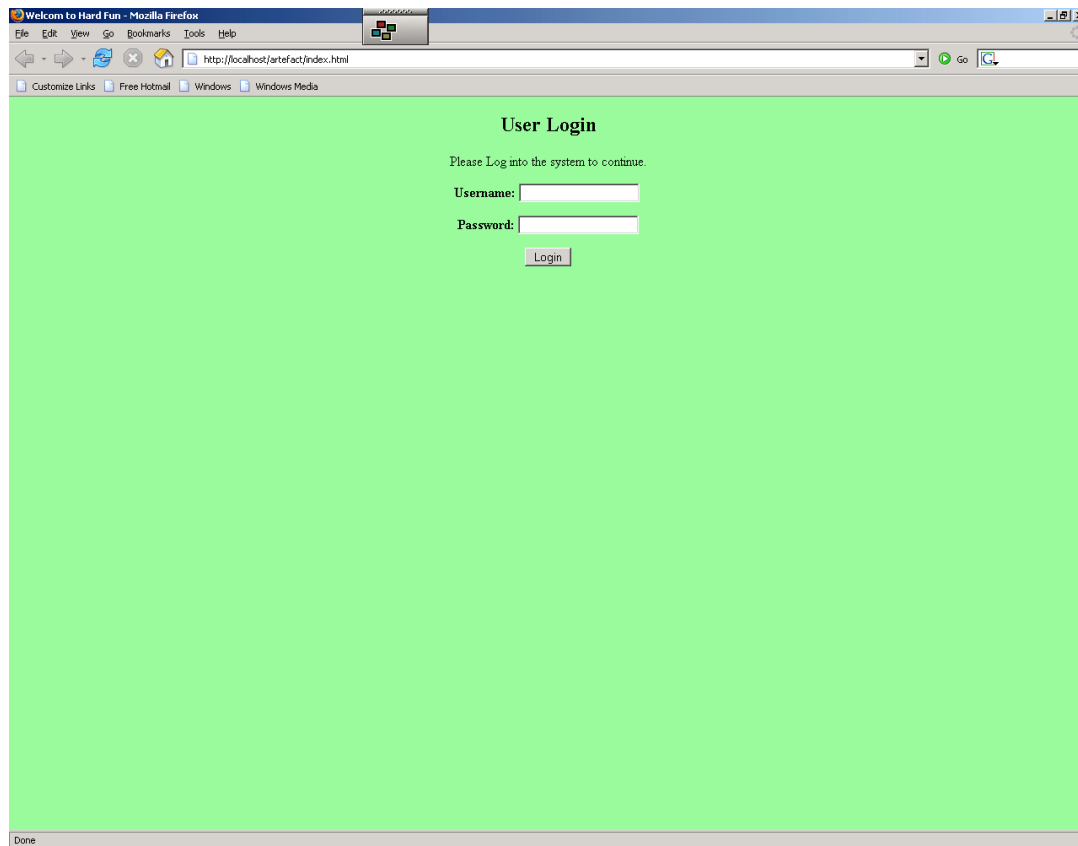
The system is described from the perspective of the administrator and the users. While the administrator can access all of the general user functions, they also have some extra functionality for the purposes of controlling access and adding new information to the system as required.

## User functions

Within the system, the user can login, select topics and questions, set questions for their peers and read and send messages to other users. Before a user can access the system, they have to be registered by the administrator. Once registered, the user has access to the system as described in the following sections.

### User login

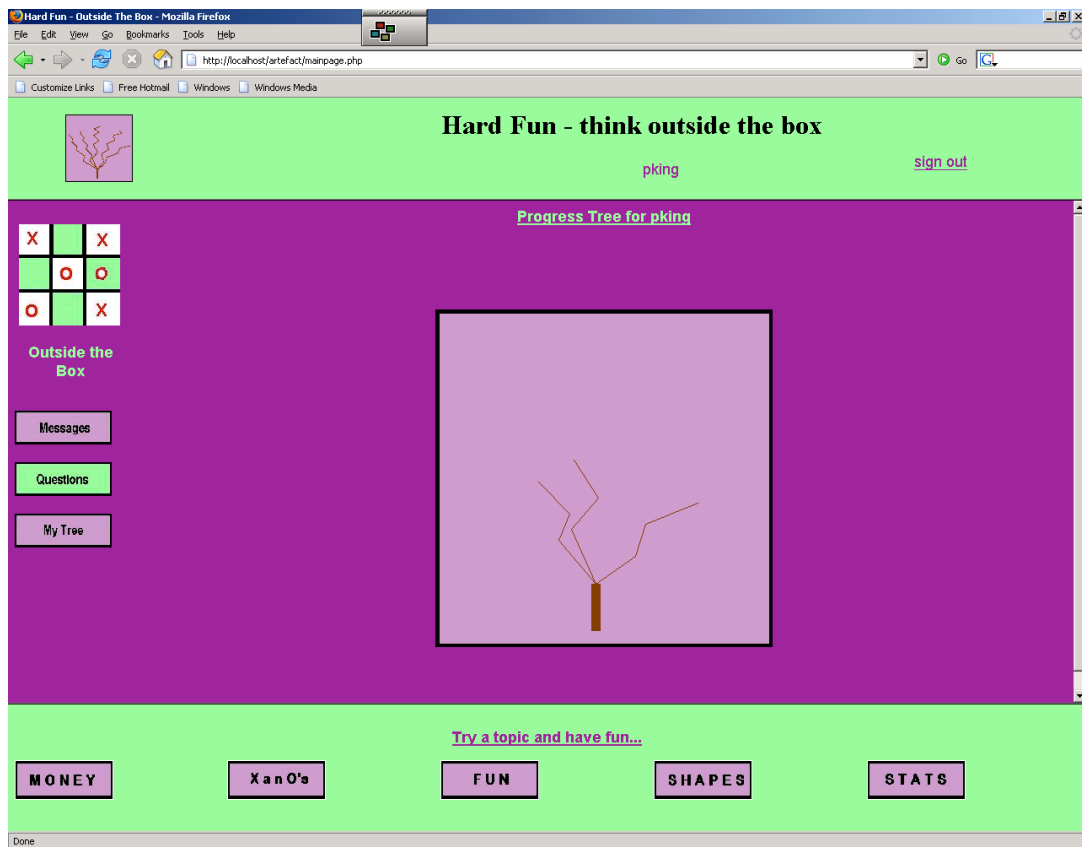
When the system loads up initially, the user is presented with the login screen shown in Figure 1 below.



**Figure 1 User Login Screen**

Once logged in, the system retrieves the current information for this user and “remembers” the questions answered and any other progress made. The progress is presented to the user in the main section of this page using a tree to represent prior success, as shown in Figure 2. This helps to improve the motivation of the student.





**Figure 2 Progress for pking**

## Topics and questions

The user can select topics from any of those listed in the bottom frame of the main page. Once a topic is chosen and a question selected, the student can enter an answer or request a hint. A sample question for the Money topic, Question 1 is shown below in Figure 3.

There are hints available for all questions. The questions are presented in informal, light-hearted and easily understood English. As students will be setting a significant number of questions, the use of visuals is limited.

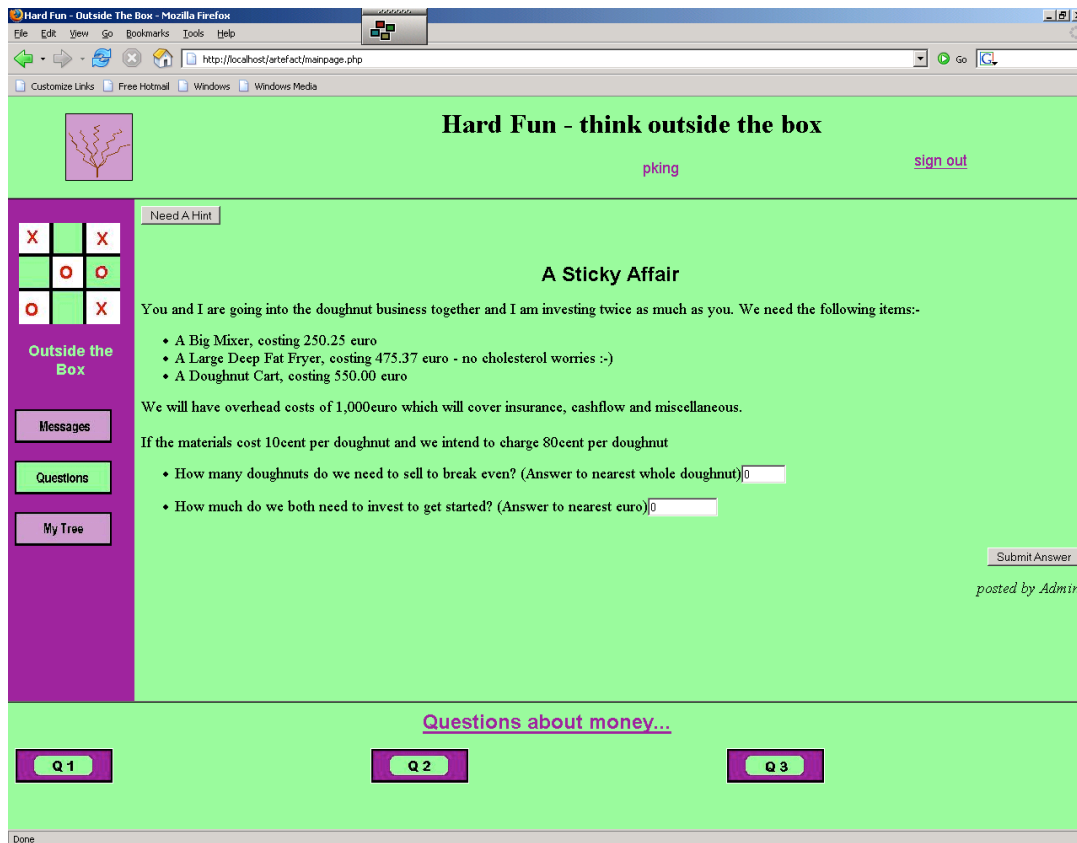


Figure 3: Sample Question about Money

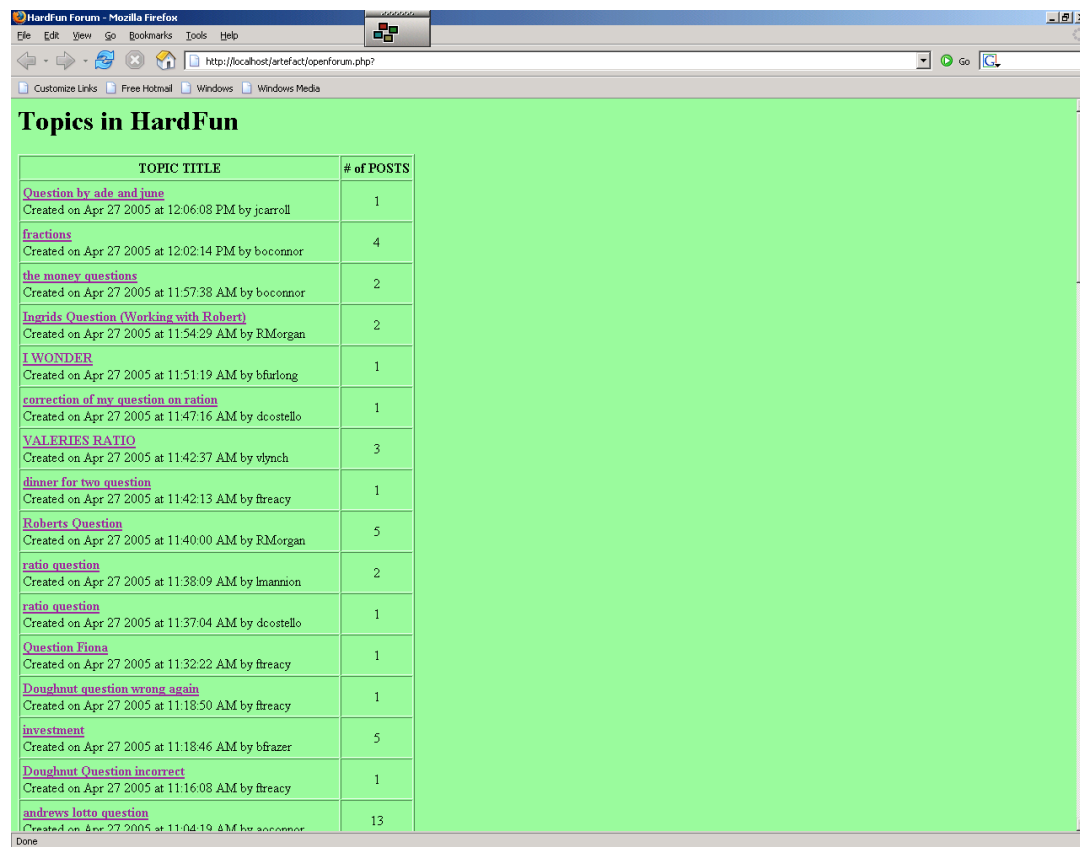
At any stage the user may access the discussion forum to ask for peer help or to present their own question for other users to attempt. The creator of the question offers feedback to others who attempted their questions, enhancing collaboration between users and creating a friendly rivalry within the group.

Successful completion of a question set by the administrator earns the user a piece of their tree. This tree is visible on the main screen after user login. This creates a dynamic and visual representation of their success and progress within the system. This helps with motivation, direction of learning and distance from success or failure in conventional exam scenarios. Each topic has its own branch system and each successful question answered offers another sub-branch. Hence a strength in, for example, statistics will dictate the shape of the tree, providing another source of discussion and levity between students.

## Discussion Forum

In a collaborative fun environment, it is a good idea to encourage dialog between the users of the system. This is achieved using a discussion forum. This allows the users to ask each other for help with questions, “comment” on the content of the question posed by each other and create a friendly rivalry on success in topics.

The discussion forum is accessed at any time by pressing the “Messages” button on the main screen and is shown in Figure 4 below. Users can create a new topic for discussion or answer posts by other users.



TOPIC TITLE	# of POSTS
<a href="#">Question by ade and june</a> Created on Apr 27 2005 at 12:06:08 PM by jcarroll	1
<a href="#">fractions</a> Created on Apr 27 2005 at 12:02:14 PM by bocconnor	4
<a href="#">the money questions</a> Created on Apr 27 2005 at 11:57:38 AM by bocconnor	2
<a href="#">Ingrids Question (Working with Robert)</a> Created on Apr 27 2005 at 11:54:29 AM by RMorgan	2
<a href="#">I WONDER</a> Created on Apr 27 2005 at 11:51:19 AM by bfurlong	1
<a href="#">correction of my question on ration</a> Created on Apr 27 2005 at 11:47:16 AM by dcostello	1
<a href="#">VALERIES RATIO</a> Created on Apr 27 2005 at 11:42:37 AM by vlynch	3
<a href="#">dinner for two question</a> Created on Apr 27 2005 at 11:42:13 AM by freacy	1
<a href="#">Roberts Question</a> Created on Apr 27 2005 at 11:40:00 AM by RMorgan	5
<a href="#">ratio question</a> Created on Apr 27 2005 at 11:38:09 AM by Imannion	2
<a href="#">ratio question</a> Created on Apr 27 2005 at 11:37:04 AM by dcostello	1
<a href="#">Question Fiona</a> Created on Apr 27 2005 at 11:32:22 AM by freacy	1
<a href="#">Doughnut question wrong again</a> Created on Apr 27 2005 at 11:18:50 AM by freacy	1
<a href="#">investment</a> Created on Apr 27 2005 at 11:18:46 AM by bfrazier	5
<a href="#">Doughnut Question incorrect</a> Created on Apr 27 2005 at 11:16:08 AM by freacy	1
<a href="#">andrews lotto question</a> Created on Apr 27 2005 at 11:04:19 AM by bocconnor	13

Figure 4 The discussion forum

## Administrator functions

In addition to the above user functions, the administrator has the capacity to add new users to the system, as shown in Figure 5 below.

### Add New User

Hard Fun - think outside the box

admin sign out

### Add A New User

Fields marked with an asterisk are required.

\*Username:

\*Full Name:

\*Password:

Access Level: ☒ User ☐ Administrator

Email Address:

Try a topic and have fun...

MONEY X a n O's FUN SHAPES STATS

Figure 5 Add new user

### Add new questions

When questions are submitted from students, via the discussion forum, the administrator can create a new php file and a new entry in the database for this question. The php files for all questions are of the same format with common elements for giving hints, checking answers and updating scores.

## *Conclusion*

This chapter justifies from a progressive educational perspective the design and functionality of this technological learning experience. While its functionality and layout may not be ideal, its colours, use of English and ease of navigation should yield positive results for the student with learned helplessness or helpless attributional style.

## **Implementation of the learning experience**

### *Overview*

The aim of this study was to examine whether a group of third level students were predisposed to learned helplessness and helpless attributional style, to present them with an alternative method of conceptualising mathematics and to assess if their symptoms of learned helplessness and helpless attributional style, with respect to learning mathematics, had or had not improved. This section describes how the design of the learning experience was implemented.

### *Participants*

Galway-Mayo Institute of Technology has run a highly successful Foundation Certificate for Access students since 2000. The participants in this research were 35 students, registered for this certificate for the academic year 2004-05. The group consisted of 25 females and 10 males, aged between 23 and 55 years. From initial meetings with this group in October 2004, there existed a general feeling of unease with respect to learning mathematics.

### *Procedure*

The Attributional Style Questionnaire (Appendix 2) was administered to participants, along with a consent form to partake in the research (Appendix 1). Participants were presented with the artefact over four two-hour sessions. At the first session, students were given the user manual for the software (Appendix 5) and a brief overview of the artefact. As all of the participants are studying IT skills, it was deemed unnecessary to administer training in logging onto the network or use of keyboard and mouse. Participants were encouraged to start their session with the Fun topic, so as to alleviate fear of either the technology or the mathematical content. Once comfortable with the link buttons and the fun aspects of the artefact, participants were encouraged to attempt the more challenging questions posed within the product.

At subsequent sessions, participants were encouraged to use the message forum to create their own mathematical questions, from within their own frame of reference and knowledge base. Students were encouraged to reply to questions posed by others and to reply to those who had answered their postings.

Lecturer intervention was quite minimal during the eight hours. Some participants had difficulty with logging on, as the software was case sensitive and others had some difficulty with the initial navigation of the site. Owing to the size of the group, adjoining IT laboratories were needed, and therefore each group worked independently of lecturer intervention for half of each session and without any difficulty.

Participants consented to some video footage of the session, which were quite jovial and light-hearted (see Appendix 6 on CD for footage). After the sessions, participants were required to complete a post-artefact questionnaire that endeavoured to measure an improvement of learned helplessness and helpless attributional style symptoms and the general attitude towards this alternative learning experience (Appendix 3).

## *Conclusion*

After the initial problems for people logging onto the system for the first time and discovering how to navigate the web site, the students appeared to have no major problems with the package. The software had some minor bugs and there was some ambiguity as to the number of places of decimal that was required for some answers. These issues could be easily overcome for future use of the artefact by debugging the software and wording the questions more precisely.

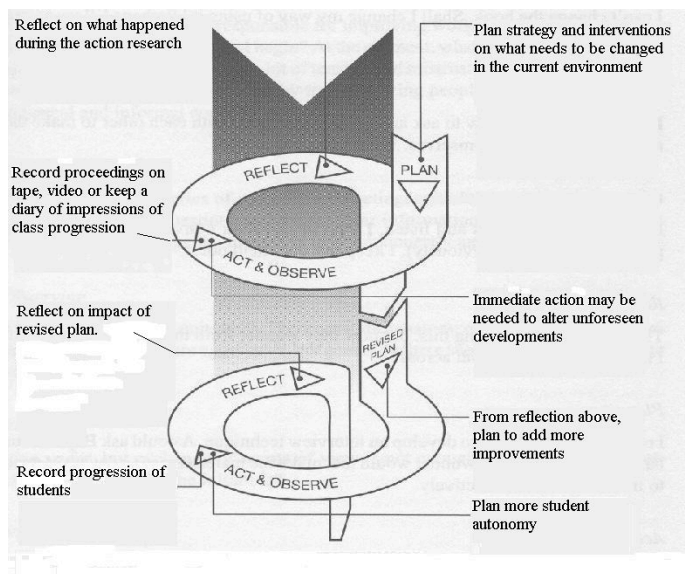
# Methodology

## Overview

This section discusses the methods used in this research. It demonstrates how learned helplessness and helpless attributional style are measured quantitatively. The benefits and limitations for adopting this approach are discussed. This is followed by a discussion on the type of data and collection tools utilised.

## Action Research

Action research was deemed the most suitable approach for implementing and evaluating the results of this research. As outlined in Figure 6, the model of planning, acting, observing and reflecting on the key theorists and the design, implementation and evaluation of the learning experience are held together by the common goal of creating a positive impact on the student suffering from learned helplessness and helpless attributional style (Kemmis & McTaggart, 1988). As little research into these conditions and mathematics learning exists, this work is viewed as a foundation for much more reflection and planning of other technological learning interventions and so the cycle of the Kemmis and McTaggart approach will continue.





**Figure 6 Kemmis & McTaggart conceptualisation of action research**

### *Triangulation of quantitative and qualitative data analysis*

As the results of the attributional style questionnaire have been validated as being measurable quantitatively, this route is taken for this analysis. Use of facts and figures alone however, in a controlled and objective way will not necessarily address the subtleties of the helpless learner of mathematics. Hence both quantitative and qualitative paradigms were considered, so as to maximise the reliability and validity of the research approach (Blaxter, Hughes & Tight, 2002).

### *Actual scoring of the ASQ*

For each response, respondents mark an answer in the range of 1 to 7. For good events (the 1<sup>st</sup>, 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup> and 12<sup>th</sup> situations), a score of 1 is lowest, or the worst possible score. Conversely, for bad events (2<sup>nd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, and 11<sup>th</sup> situations), a score of 1 is highest, or the best possible score. Because of the reverse order of scoring for good and bad events, scores for good events must be separated from scores for bad events (Seligman et al., 1984).

Data on respondents may be analysed as follows:

- Composite Negative Attributional Style (CoNeg) – sum the total of all bad event scores and divide by the total number of bad events, 6. The best score is 3, the worst score is 21.
- Composite Positive Attributional Style (CoPos) – sum the total of all good events scores and divide by the total number of good events, 6. The best score is 21, the worst score is 3.
- Composite Positive minus Composite Negative (CPCN), yields a best score of +18 and a worst score of –18.

The following is a list of the individual dimension measures:

- Internal negative – sum the answers of the second question under each bad event and divide by the total number of bad events, 6. They are questions 6,14, 18, 26, 30, 42.
- Stable negative – sum the answers of the third question under each bad event and divide by the total number of bad events, 6. They are questions 7,15, 19, 27, 31, 43.
- Global negative – sum the answers of the fourth question under each bad event and divide by the total number of bad events, 6. They are questions 8, 16, 20, 28, 32, 44.
- Internal positive – sum the answers of the second question under each good event and divide by the total number of good events, 6. They are questions 2, 10, 22, 34, 38, 46.
- Stable positive – sum the answers of the third question under each good event and divide by the total number of good events, 6. They are questions 3, 11, 23, 35, 39, 47.
- Global positive – sum the answers of the fourth question under each good event and divide by the total number of good events, 6. They are questions 4, 12, 24, 36, 40, 48.

Finally a measure of hopelessness or hopefulness may be measured as follows:

- Hopelessness – sum the stable negative and global negative scores and divide by 2.
- Hopefulness – sum the stable positive and global positive scores and divide by 2.

Microsoft Excel can easily handle the computation of the various measures, and is shown in summary format in Appendix 7 (or ASQAnalysisForThesis.xls on CD).

### *Reliability of ASQ results and transfer of findings to the sufferer of mathematics anxiety*

CPCN and CoNeg and to a lesser extent CoPos scores were found to be the most valid and reliable in the prediction of depression and various other outcomes. The individual dimension scores (internal, stable and global), because they are based on only a few questions, have a much lower reliability and validity (Seligman et al., 1984).

The ASQ has been used thus far as a research instrument and employed successfully with college students (Seligman et al., 1984), clinically depressed individuals (Raps, et al., 1984) and people undergoing various stressful events (O Hara, Rehm, Campbell, 1982; Manly, McMahon, Bradley, Davidson, 1982). Although the ASQ has been employed predominantly in studies of depression, there are studies that indicate that the scale may be applied to research on achievement, motivation, self esteem, responses to aversive life events, life change, gender and sex role differences in casual attributions and parental behaviour (Lefcourt, Martin, Ware, 1984; Firmin et al., 2004; Peterson & Barrett 1987; Kashdan et al., 2000). For the purpose of this research therefore, it is reasonable to assume that the ASQ is a valid measure of attributional style, and hence a measure of learned helplessness and helpless attributional style. It may also be reasonable to assume that the scores obtained by participants in this research may be used as a measure of these symptoms with respect to learning mathematics, by assuming that of symptoms of positive or negative attributional style for the generic hypothetical events outlined in the ASQ may be transferred to those experienced while learning mathematics. As such a vast amount of data is collected (11 outcomes by 36 students = 396 data sources), it is reasonable to address data on CPCN and internal negative scores, and only for those students who display symptoms of helpless attributional style, i.e. those with negative CPCN scores. However, general observations are made on other note-worthy trends which may occur.

The post-artefact questionnaire (Appendix 3) endeavours to measure if symptoms of helpless attributional style and internal negative attributions demonstrate alteration from ASQ findings. Upon completion of the 8 hours exposure to the artefact, students are asked 10 questions. Results from questions 1 and 2 may be used similarly to questions posed in the ASQ, by allowing a measure of internal negative or positive attributions. As the product endeavoured to incorporate a hard mathematics and a fun aspect to learning mathematics, questions 3 and 4 offers a measure of these. Question 5 asks if the students found the experience beneficial, while question 6 asks if the student's view of mathematics might now be altered. Question 7 asks whether the student thinks that using software like this could influence their performance in conventional exams. It is envisaged that the answers to these questions will offer a qualitative view on whether the artefact helped students whose attributional style was negative. The final three questions, are not used for measurement of attributional style, but serve as fed back to the researcher on students overall impression of the artefact and suggested improvements for its future use.

The ASQ is a peer-reviewed and validated document and the post-artefact questionnaire is not. However, the ASQ does not relate directly to sufferers of learned helplessness and helpless attributional style with respect to mathematics, whereas the latter endeavours to focus specifically on alterations in participants' attitudes towards mathematics. It may be reasonable therefore, to assume that using both questionnaires as outlined above are valid within the scope of a paper at masters degree level.

## *Conclusion*

The scope of this thesis does not allow for an in-depth perspective on all of the results of the ASQ. Also while the post-artefact questionnaire endeavours to create a relative measurement to the ASQ, it would require expert critical analysis and refinement in order to become itself a fully authentic measure of symptoms. Had the duration of this work been longer and more in-depth, these limitations could have been addressed. However, it is still reasonable to assume that another

researcher working within the remit outlined above would draw similar conclusions to those here and that the level of subjectivity is minimised, if not fully eliminated.

## Evaluation and Key Findings

### *Overview*

This section outlines how the quantitative data collected was analysed. Reflections on the researcher observations are outlined and the key findings and surprise outcomes of the research are recorded.

### *The ASQ*

As evaluation of the results of the ASQ is quite detailed, the results were collated in MS Excel (Appendix 7 on CD). For the purpose of this analysis, a limitation on the synthesis of the results was required. Participants were classified as follows:

#### Group 1.

Those suffering from of learned helplessness and helpless attributional style with a CPCN score of under 0.

#### Group 2

Those not suffering from learned helplessness or helpless attributional style, but who did not show significant hopefulness in their attributions and had a CPCN score of 0 but less than 6.

#### Group 3

Non-sufferers of learned helplessness or helpless attributional style, but who also show significant hopefulness in their casual attributions with a CPCN score of 6 or higher.

This classification will be used as the basis for the assimilation of results from the post-artefact questionnaire. A detailed analysis of the first group above is outlined and general observations from the other two groups' results.

### Group 1 – Analysis

Eight students were identified under classification 1 as outlined above, the CPCN scores of between -1 and -7. The full results for this group are presented in

Appendix 7. The Post Artefact Questionnaire can be used as a measure of internal negative attributions, by using the results of questions 1 and 2 combined and measured using the ASQ scoring system, as shown in Table 1, with the allocated Internal Negative ratings shown in red.

Question 1 What is your overall experience of using this product?			
Great	Good	No so good	Bad
Positive outcomes (ASQ score of 1 is lowest)		Negative outcomes (ASQ score of 7 is lowest)	
Question 2 Is the cause of your experience outlined above due to something about you, or something about other people or circumstances?			
	Due to others	50:50	Due to me
For 'Great' in Q1	2	5	7
For 'Good' in Q1	1	4	6
For 'Not so good' in Q1	6	5	2
For 'Bad' in Q1	7	4	1

**Table 1 ASQ Scoring system for post-artefact questionnaire**

Table 2 shows the relative measure of internal negative attributions between the ASQ scores for the 8 students and that calculated using the table above.

Student ID	InternalNeg from ASQ	InternalNeg from Post Artefact Questionnaire
7	5	4
15	4	4
19	6	4
20	5	4
25	6	5
32	6	6
33	5	4
34	5	5

**Table 2 Relative measure of internal negative attributions**

Comparison of the results between pre and post artefact intervention for negative attributional style show improvement in 5 students, with no change in 3. While these results may not be remarkable, their limitation must be acknowledged in that they are based on a small number of questions. When analysed however in conjunction with the answers to the other post-artefact questionnaire questions, which can be qualitatively analysed, the results suggest that in addition to the above:

- All 8 students considered the alternative view of mathematics to be helpful.
- 5 out of the 8 students considered that the experience would influence their attitude towards mathematics in the future.
- 5 out of the 8 students considered that the experience would influence their future performance in conventional mathematics examinations.
- 3 out of the 8 students considered the experience to be lots of fun, while 5 more considered it some fun (no student found it to be no fun).
- 7 out of 8 students considered some of the questions hard, while just 1 found all of the questions hard.
- Under the comments sections of the post-artefact questionnaire, these 8 students liked:
  - The real-life dimensions to the questions.
  - The ability to set questions themselves for peers.
  - The collaborative aspects of the discussion forum.
  - The ability to think about mathematics at a different level to the conventional classroom setting.
  - The fun aspect of the experience.
- The students disliked:
  - The fact that some of the mathematics was hard.
  - The fact that they felt they were understanding the mathematics more slowly than others.
  - The fact that an answer was either right or wrong (no margin for minor error).
  - 3 students considered there to be nothing that they disliked about the experience.
- When asked on an overall comment on their experience, students suggested:



- That the experience was a fun way to learn mathematics.
- That interacting with peers and setting their own questions was empowering.
- That they would prefer to learn this way.
- One student considered the layout of the message forum to be difficult to navigate.
- Just one student suggested that conventional methods of teaching mathematics were superior to this leaning experience.

## Group 2 – Analysis

Twenty students gained CPCN scores of between 0 and less than 6 (59% of the group). The full results for this group are presented in Appendix 8. Twelve of these students presented with high internal negative scores implying that they previously perceived events to be their fault. However, in the post-artefact questionnaire, all of these students attributed their positive experience either totally to themselves or on a 50/50 basis. This would imply an improved self-perception and hence an improved self-belief. These students can now aspire to the limitations of their logical/mathematical intelligence as described by Gardner (1989) rather than the limitations of their own self-beliefs.

## Group 3 – Analysis

There are six students in this group with a CPCN of 6 or above. This group serves as a control group in determining whether or not the alternative learning experience can have a positive affect on students who do not suffer from learned helplessness or helpless attributional style. The full results are presented in Appendix 9. These students enjoyed the experience, and while they were equally divided on whether the artefact altered their future perception of mathematics, they all considered that the alternative presentation of mathematics, outside of the traditional classroom environment helped in understanding the problems and altered their approach to solving mathematics questions. They were generally enthusiastic, with one comment that the artefact had “great potential when used with conventional

classes”. They liked having the opportunity of setting questions for each other and considered that this provided good interaction and a sense of achievement.

### *Researcher Observations*

The fact that the actual mathematics contained in this learning experience had to be performed using paper and calculator ensured that the skills students require for conventional mathematics examinations were still utilised.

The initial session was over three hours and so students were given a half-hour break in the middle of the session. All but five students returned within 20 minutes. This level of enthusiasm is very refreshing for any educator.

As seen on the video clip on the CD, students sitting side-by-side helped each other and on several occasions they spontaneously worked in pairs in posing a question on the forum, as they tried to ‘out-do’ the questions set by the perceived smarter students in the group. Hence the friendly rivalry envisaged in the design materialised.

The sessions were very light hearted with the tutor looking at tree shapes and making playful comments to the student, and within earshot of others. This created more determination in the student and no-one reacted badly to the gentle gibes.

The only regret was that the exposure to the learning experience was not earlier in the academic year, perhaps at the start of semester 2, and that perhaps 8 sessions could not have been accommodated. The entire experience was a little too rushed and too near the examinations.

### *Some Surprising Findings*

- One student who had a CPCN score of  $-1$  (student 34) suggested in her post- artefact questionnaire that she found the experience less useful than the conventional maths class. Interestingly this same student has gained over 70% in continuous assessment to date and would therefore concur with the findings of Houston (1994) that some sufferers of learned helplessness and helpless attributional style are more steely in their approach to learning.
- Many students whose continuous assessment marks for the year to date were quite poor were in Group 2 and one such student was actually in Group 3. This suggests that poor performance in mathematics does not correlate positively with suffering from learned helplessness or helpless attributional style. However, as all of these students found the alternative learning experience useful and many had significant success in building a very respectable tree, there exists preliminary proof that conventional syllabus mathematics is inherently flawed. These students have difficulty learning algebra, but can answer the artefact questions in the X and Os section of the artefact, which is applied algebra!
- One student has serious personal issues, no learned helplessness (CPCN of 5) but major problems within the conventional mathematics class. This student is an avid horse bettor and managed to set a betting question which just one person in the group successfully answered. The absolute joy of this student, and his amazing ability to work out this type of mathematics, without using a calculator made this entire two years of research worthwhile. He promised to work really hard so as to pass the end-of-year examination and now believes that he has something worthwhile to offer to the world.

## Summary and Conclusions

### *Researcher reflections*

The Access student is a very special type of person. They are returning to education because of a burning desire to pick up a part of their lives that eluded them in their youth. They are fearful but enthusiastic, often helpless but willing. They are trusting of those genuinely interested in helping them. On the whole, this Access group embraced this learning experience. Its potential for helping others, even those who do not suffer from learned helplessness and helpless attributional style, has become apparent. Further research in this area is inevitable.

### *Summary*

Fear of learning mathematics, whether it is anxiety (Tobias, 1978), affect (McLeod, 1992), Mathophobia (Papert, 1993) or learned helplessness (Seligman, 1989), definitely exists in the adult learner. Formal education still places enormous emphasis on the end product of examination success, rather than on the process of learning and knowledge construction. Papert advocates allowing the student to construct knowledge that is of interest to them, to learn from their own frame of reference and to build on their own experience, in order to acquire new knowledge and skills.

Use of the literature on progressive educational methods created the basis for the design of this learning experience and use of technologies. This study initially set out to test for learned helplessness and helpless attributional style in 34 Access students. It presented the group with an alternative technological artefact and measured again for improvements in symptoms of learned helplessness and helpless attributional style.

Working within an action research framework, the findings suggest that those suffering from this type of mathematics anxiety showed both quantitative and qualitative improvements in their symptoms. An argument for using this type of

learning experience for all students, including those who are not afraid of learning mathematics can now be made, as these students also found the alternative learning environment to be beneficial.

### *Recommendations*

The cycle of action research, as described by Kemmis and McTaggart (1988), is an evolution of planning, implementing, acting, reflecting and re-planning. This work completed this cycle once. It has become a new base point from which all adult learners of mathematics, and not just those who suffer from anxieties and fears, may find greater satisfaction, interest and applicability of this most important subject. The recommendations for improvements of the artefact, as expressed on the post-artefact questionnaire would be a good starting point for future research.

The improved learning experience could then be tested in other third level institutions, where Access programs are becoming an important addition to student populations. With government policies in Ireland leaning towards third level institutions competing with each other for funding, there will be an obvious future focus on the importance of Access programs. An institutions ability to communicate remotely with students and create web-based training programs will become paramount. The educational soundness of these programs will also be crucial. Perhaps a learning experience like this one could spearhead such developments.

Seligman's latest book is called Learned Optimism (1998). This concept is the way forward. Rather than focus on the limitations of ones ability, focus should be clearly on one's natural ability. As educators, our duty is not to have students fail, because they can not gain a 40% grade in an exam. Rather we should help them to find their interests, create their own paths of discovery, empower them to take control of their learning and succeed to reach their potential.

## **Appendix 1- Signed agreement to partake in research**

Research by Fiona Watson into learned helplessness and fear  
of mathematics.

I, \_\_\_\_\_, am willing to partake in this research being carried  
out by Fiona Watson

## Appendix 2 – The ASQ

page 1

### ATTRIBUTIONAL STYLE QUESTIONNAIRE

#### Directions:

- 1) Read each situation and vividly imagine it happening to you.
- 2) Decide what you believe to be the one major cause of the situation if it happened to you.
- 3) Write this cause in the blank provided.
- 4) Answer the six questions about the cause by circling one number per question. Do not circle the words.
- 5) Go on to the next situation.

#### SITUATIONS

YOU MEET A FRIEND WHO COMPLIMENTS YOU ON YOUR APPEARANCE.

1. Write down the one major cause: \_\_\_\_\_
2. Is the cause of your friend's compliment due to something about you or something about other people or circumstances?  

Totally due to other people or circumstances	1	2	3	4	5	6	7	Totally due to me
--	---	---	---	---	---	---	---	-------------------
3. In the future, when you are with your friend, will this cause again be present?  

Will never again be present	1	2	3	4	5	6	7	Will always be present
-----------------------------	---	---	---	---	---	---	---	------------------------
4. Is the cause something that just affects interacting with friends, or does it also influence other areas of your life?  

Influences just this particular situation	1	2	3	4	5	6	7	Influences all situations in my life
---	---	---	---	---	---	---	---	--------------------------------------

YOU HAVE BEEN LOOKING FOR A JOB UNSUCCESSFULLY FOR SOME TIME.

5. Write down the one major cause: \_\_\_\_\_
6. Is the cause of your unsuccessful job search due to something about you or something about other people or circumstances?  

Totally due to other people or circumstances	1	2	3	4	5	6	7	Totally due to me
--	---	---	---	---	---	---	---	-------------------
7. In the future, when looking for a job, will this cause again be present?  

Will never again be present	1	2	3	4	5	6	7	Will always be present
-----------------------------	---	---	---	---	---	---	---	------------------------
8. Is the cause something that just influences looking for a job, or does it also influence other areas of your life?  

Influences just this particular situation	1	2	3	4	5	6	7	Influences all situations in my life
---	---	---	---	---	---	---	---	--------------------------------------

Copyright 1984 by Dr. Martin E.P. Seligman. All rights reserved. Dr. Martin E.P. Seligman acknowledges the significant contribution of Dr. Mary Anne Layden to the authorship of this questionnaire.

YOU BECOME VERY RICH.

9. Write down the one major cause: \_\_\_\_\_  
\_\_\_\_\_

10. Is the cause of your becoming rich due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

11. In the future, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

12. Is the cause something that just affects obtaining money, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---

A FRIEND COMES TO YOU WITH A PROBLEM AND YOU DON'T TRY TO HELP HIM/HER.

13. Write down the one major cause: \_\_\_\_\_  
\_\_\_\_\_

14. Is the cause of your not helping your friend due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

15. In the future, when a friend comes to you with a problem, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

16. Is the cause something that just affects what happens when a friend comes to you with a problem, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---



I GIVE AN IMPORTANT TALK IN FRONT OF A GROUP AND THE AUDIENCE REACTS NEGATIVELY.

Write down the one major cause: \_\_\_\_\_

Is the cause of audience's negative reaction due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
--	---------------	-------------------

In the future when you give talks, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
-----------------------------	---------------	------------------------

Is the cause something that just influences giving talks, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
---	---------------	--------------------------------------

I DO A PROJECT WHICH IS HIGHLY PRAISED.

Write down the one major cause: \_\_\_\_\_

Is the cause of your being praised due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
--	---------------	-------------------

In the future when you do a project, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
-----------------------------	---------------	------------------------

Is the cause something that just affects doing projects, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
---	---------------	--------------------------------------

YOU MEET A FRIEND WHO ACTS HOSTILELY TOWARDS YOU.

25. Write down the one major cause: \_\_\_\_\_

26. Is the cause of your friend acting hostile due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

27. In the future when interacting with friends, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

28. Is the cause something that just influences interacting with friends, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---

YOU CAN'T GET ALL THE WORK DONE THAT OTHERS EXPECT OF YOU.

29. Write down the one major cause: \_\_\_\_\_

30. Is the cause of your not getting the work done due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

31. In the future when doing work that others expect, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

32. Is the cause something that just affects doing work that others expect of you, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---

YOUR SPOUSE (BOYFRIEND/GIRLFRIEND) HAS BEEN TREATING YOU MORE LOVINGLY.

33. Write down the one major cause: \_\_\_\_\_

34. Is the cause of your spouse (boyfriend/girlfriend) treating you more lovingly due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

35. In future interactions with your spouse (boyfriend/girlfriend), will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

36. Is the cause something that just affects how your spouse (boyfriend/girlfriend) treats you, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---

YOU APPLY FOR A POSITION THAT YOU WANT VERY BADLY (E.G., IMPORTANT JOB, GRADUATE SCHOOL ADMISSION, ETC.) AND YOU GET IT.

37. Write down the one major cause: \_\_\_\_\_

38. Is the cause of your getting the position due to something about you or something about other people or circumstances?

Totally due to other people or circumstances	1 2 3 4 5 6 7	Totally due to me
---	---------------	-------------------

39. In the future when you apply for a position, will this cause again be present?

Will never again be present	1 2 3 4 5 6 7	Will always be present
--------------------------------	---------------	------------------------

40. Is the cause something that just influences applying for a position, or does it also influence other areas of your life?

Influences just this particular situation	1 2 3 4 5 6 7	Influences all situations in my life
--	---------------	---

YOU GO OUT ON A DATE AND IT GOES BADLY.

41. Write down the one major cause: \_\_\_\_\_

42. Is the cause of the date going badly due to something about you or something about other people or circumstances?

Totally due to other  
people or circumstances

1 2 3 4 5 6 7

Totally due to me

43. In the future when you are dating, will this cause again be present?

Will never again  
be present

1 2 3 4 5 6 7

Will always be present

44. Is the cause something that just influences dating, or does it also influence other areas of your life?

Influences just this  
particular situation

1 2 3 4 5 6 7

Influences all  
situations in my life

YOU GET A RAISE.

45. Write down the one major cause: \_\_\_\_\_

46. Is the cause of your getting a raise due to something about you or something about other people or circumstances?

Totally due to other  
people or circumstances

1 2 3 4 5 6 7

Totally due to me

47. In the future on your job, will this cause again be present?

Will never again  
be present

1 2 3 4 5 6 7

Will always be present

48. Is the cause something that just affects getting a raise, or does it also influence other areas of your life?

Influences just this  
particular situation

1 2 3 4 5 6 7

Influences all  
situations in my life

# UNIVERSITY of PENNSYLVANIA

School of Arts and Sciences

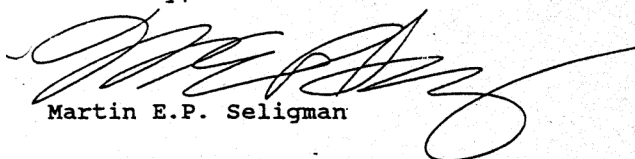
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## PERMISSION TO USE THE ATTRIBUTIONAL STYLE QUESTIONNAIRE

The Attributional Style Questionnaire (ASQ) is copyrighted material and may only be used with the written permission of the author, Dr. Martin E.P. Seligman. This letter grants you permission to use the ASQ, so please keep it on file. The questionnaire may be used only for academic research or by a clinical psychologist for the diagnosis or treatment of patients. It may not be used for profit or for any corporate-related activities.

Sincerely,



Martin E.P. Seligman

c:\wpwin\office\permis.asq

### **Appendix 3- The post-artefact questionnaire**

Questionnaire on your experience of using Hard Fun Software Package

Name: \_\_\_\_\_

1. What is your overall experience of using this product?

Great                  Good                  Not so good                  Bad

2. Is the cause of your experience outlined above due to something about you, or something about other people or circumstances?

Totally due to others                  50:50                  Totally due to me

3. Did you have fun using this product?

Lots of fun                  Some fun                  No fun

4. Did you find the questions posed in the product hard?

All Hard                  Some Hard                  None Hard

5. Did you consider this alternative view of mathematics to be helpful to you?

Yes                  No

6. Do you think that your experience with this product, will have an affect on how you might view mathematics in the future?

Yes      No

7. Do you think your experience with this product will have an affect on how you get on in your conventional maths exams?

Yes                  No

8. What was the best thing about the product?

---

---

---

---

9. What was the worst thing about the product?

---

---

---

---

10. In a few lines, give me your thoughts on this learning experience and any recommendations you would make to improve your learning experience.

---

---

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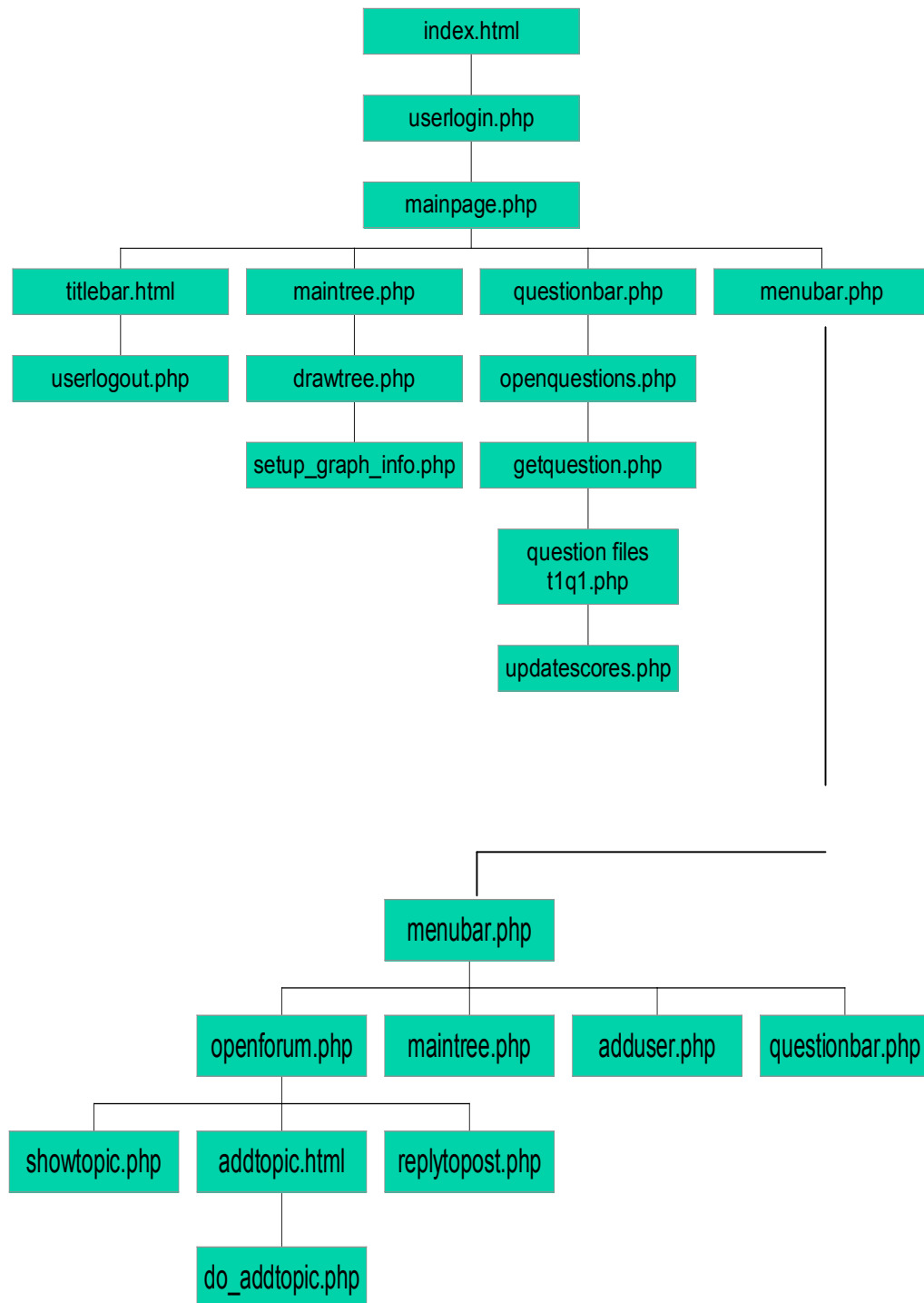
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Thank you for your time, co-operation and the pleasure of your company in my class. I wish you the very best in your exams and in your career paths next year.

Fiona

## Appendix 4 – Architectural Overview





## **Appendix 5 - User Manual for Hard Fun**

# **Hard Fun User Manual**

## **User Manual for Hard Fun**

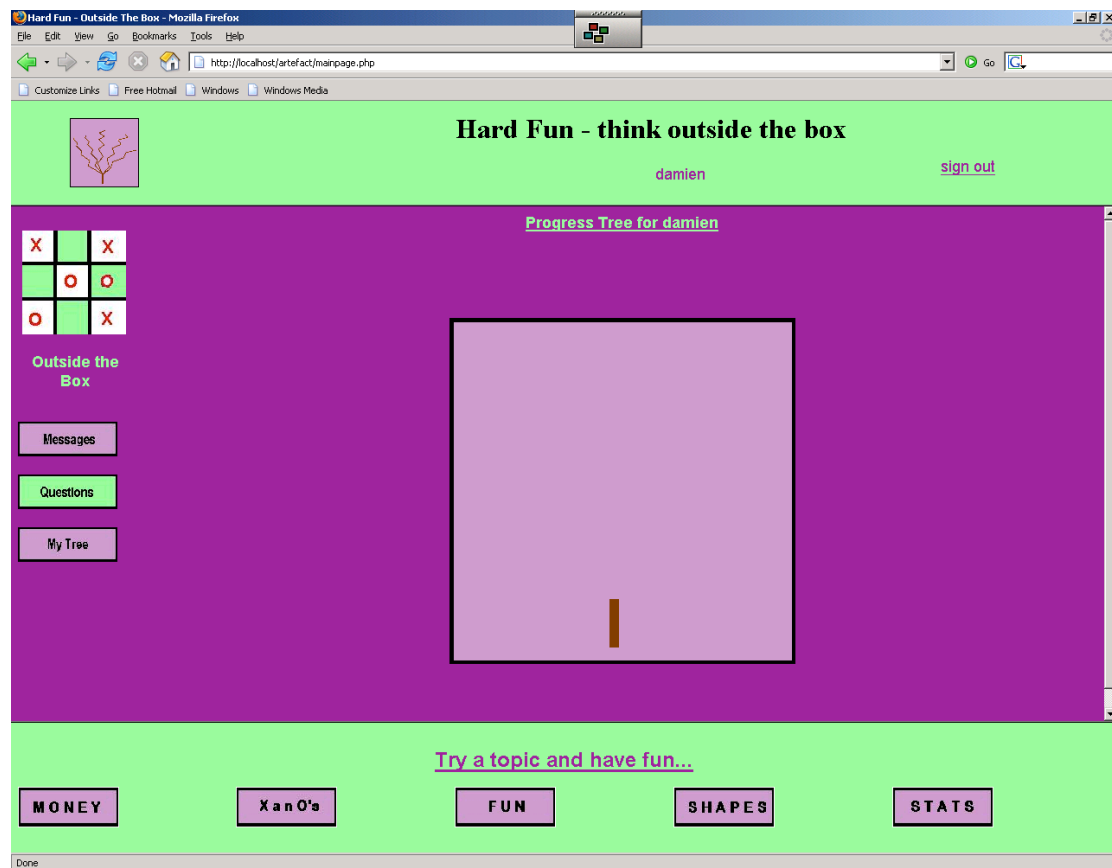
### *The Product:*

This software product has been developed by Fiona Watson as part of a research project into alternative methods of teaching and the use of technology for third level mathematics.

The software is designed to be student initiated and driven. The educational idea is to pose mathematics questions to Access students in a format and environment that is different to the syllabus and the standard classroom environment. The title 'Hard Fun' was a phrase coined by a child who partook in a similar study by a great educational researcher, called Seymour Papert. Papert had asked the child to programme robotic Lego, which involved learning measurements, speed, angles and all sorts of other mathematical feats. When asked what he thought of the learning experience, the child replied; "It's hard, it's Lego, it's fun". The idea for this product is based on this concept. If the exercise were easy, it would pose no challenge and would not broaden your learning. So it's 'hard'. But as Whoopie Goldberg once said, when she did a guest voice-over on Bear In the Big Blue House; "It is hard, but not too hard for you".

The fun aspects to the software are three fold. It's a product that looks nice and is user friendly (more about using it later). Secondly, it is removed from the conventional exam scenario which is typical for regular maths courses. This product offers a reward for your efforts by way of a tree, which grows in front of your eyes for each question that you successfully answer. So there is no need at all to fear failure, as you will only have successes here. Thirdly, the Messages option allows you to set up topics to create a discussion forum with fellow classmates. You are actively encouraged to set up a topic which is a maths question that may be similar to one within the software, but which is set by you. Other class members are then encouraged to reply to your topic or message posting and to try to answer your question. At a later stage, your questions will be moved into the main software product, and credited to you, so that the software becomes a 'living' thing, created initially by Fiona, but grown, developed, nurtured and owned by you, the student. Now that sounds like fun!

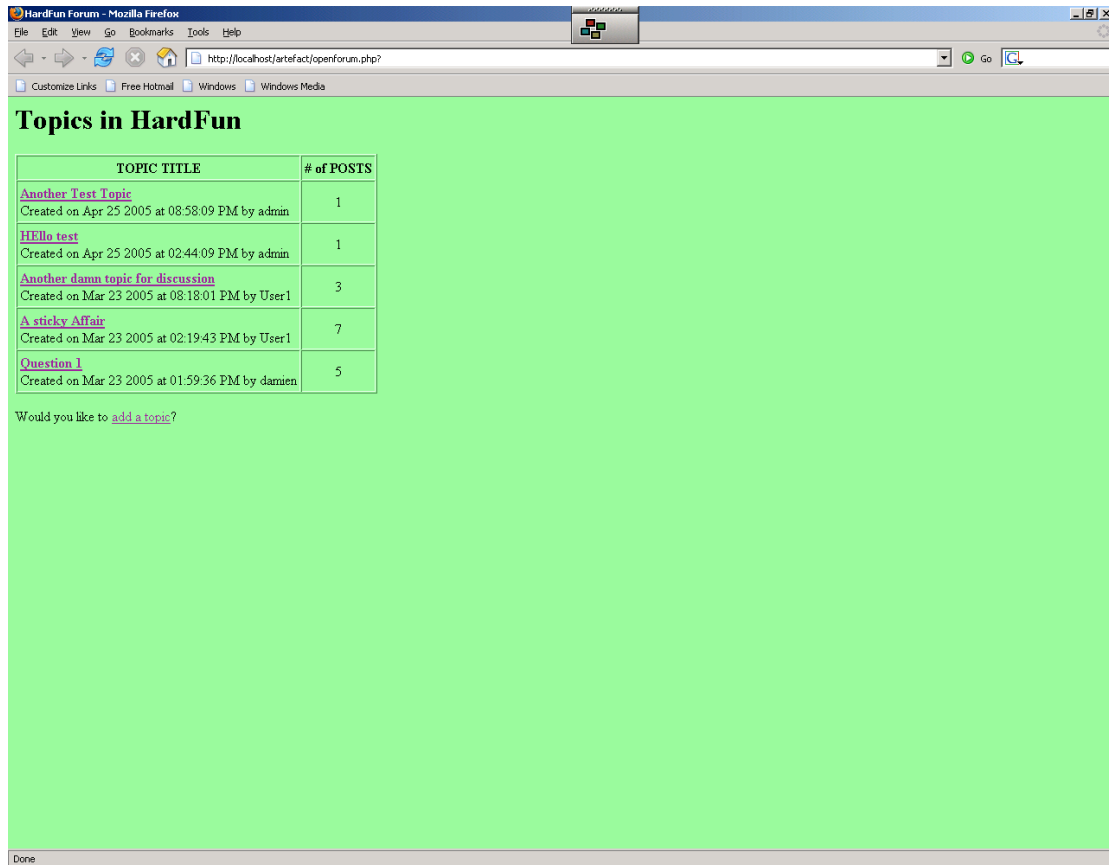
Ok, so where are you meant to start? Well, for testing purposes, you have been set up with a user name and password. Fiona has the details, so log yourself in. The screen you will see is shown in Fig1.



**Figure 7 Main Page of Hard Fun**

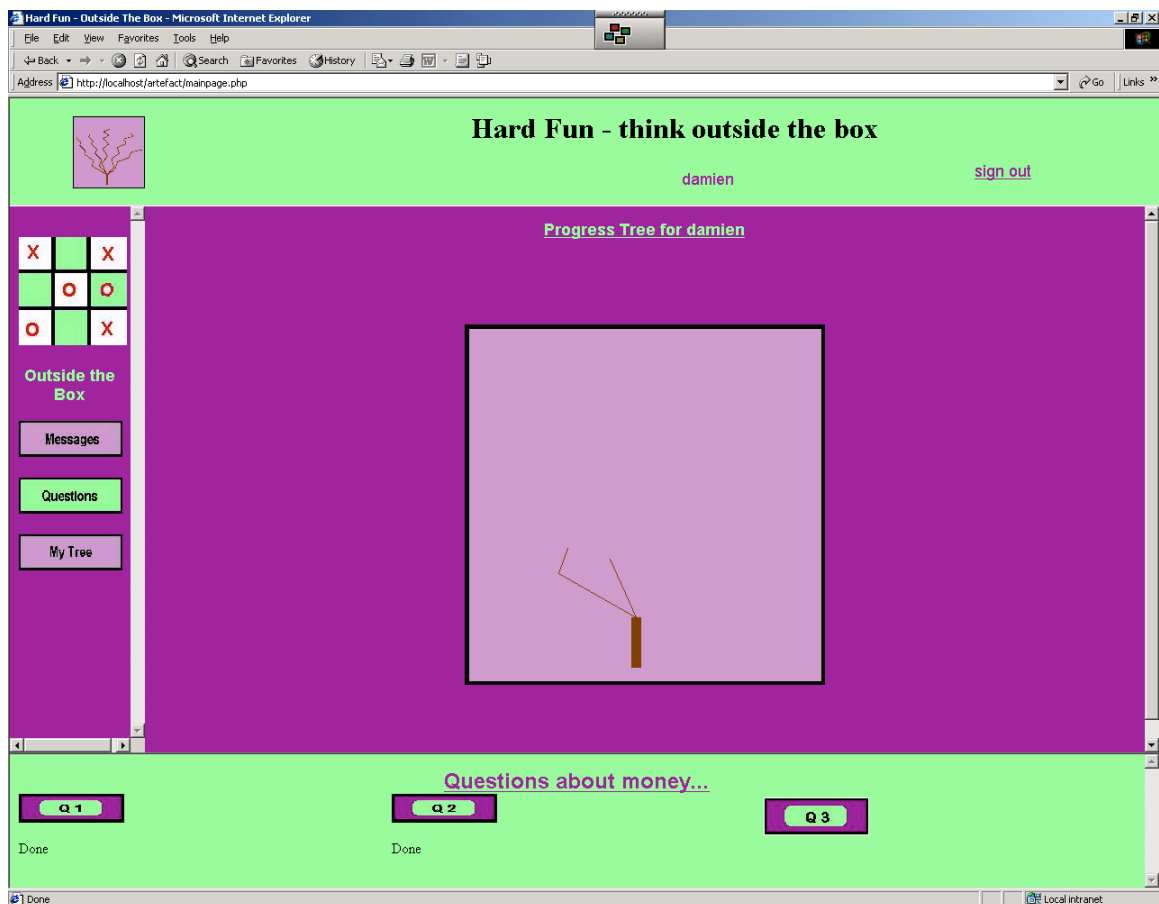
Under the main heading, 'Hard Fun' is displayed your username and logout option. The menu along the left-hand-side offers you choices, including Messages, Questions and My Tree. The bottom part of the screen initially displays the topics, in which there are a number of questions. The screen to the right of the menu bar, will display your tree or individual questions, as requested by you. So lets run through the menu options:

**Messages** – this opens the discussion forum for you to answer questions set by fellow class members or for you to create your own question. Figure 2 shows an example of some topics already submitted by users. If you wish to see the details of any of these, simply click on their title which is underlined with a purple line and view the postings. If you wish to pose a question for your classmates, click the ‘Add a Topic’ option, and the input will be credited to you. Try it!



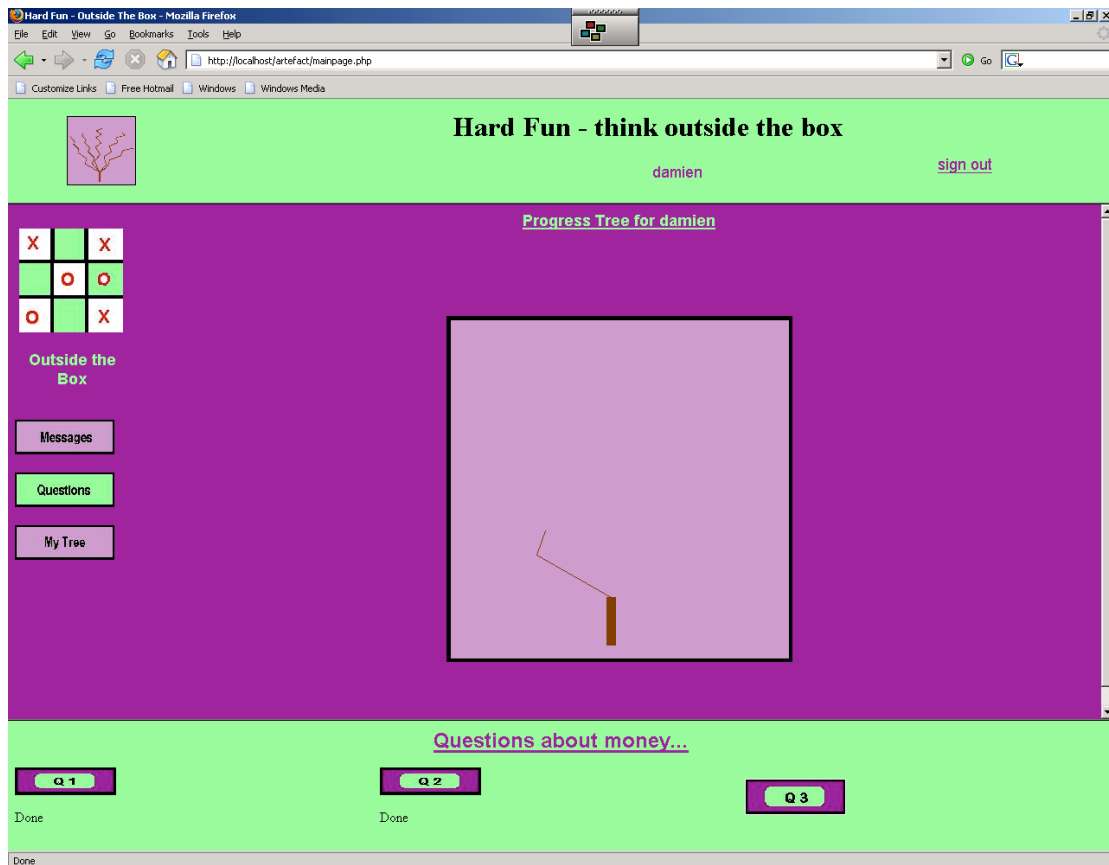
**Figure 8 Messages Forum**

**Questions** – the questions which are currently set by Fiona are accessed by pressing the Questions button, as in Figure 1 above. The question topics appear at the bottom of the main screen. Pick one, say Money. You will see a number of question options at the bottom of the screen. If you pick one of these, you will be posed with a question. You are given a box, in which you submit your answer and you can also avail of several hints, by pressing the hints button, as in Figure 3 below. If you submit the correct answer, you will be informed that you were successful and the question will show up as ‘done’, when the screen is refreshed. In Figure 3 below, for example, the user Damien has successfully answered two of the three questions on money and is about to attempt the third.



**Figure 9 The Questions**

**My Tree** – your reward for your success is by way of a tree, which will grow a part of a branch for each correct answer you get. By pressing the My Tree button, you will start with a trunk. In Figure 4, you can see that the user Damien has answered two questions about money and that his tree has grown two branches as a result! The finished tree, if you successfully answer all questions will look like that at the top left of the web page, beside the Hard Fun heading.



**Figure 10** The Tree of user Damien

### **Some possible solutions to some possible problems...**

*Q* What if I freak out and can't answer any questions within a topic?

*A* Go to the Fun Questions – they are fun, ridiculous and grow you tree branches without any huge effort. Then go to the messages, and set up a topic for your own fun riddles and questions. When you have stopped freaking out, go back and have a look at the other question areas. Remember, it's fun!!

*Q* What if I have submitted loads of answers for a question, and looked at all the available hints and still can't seem to get the right answer?

*A* Go to the messages forum, and set up a Topic called, say 'Anyone Know How to Answer the Second Money Question?' and wait a while to see if your classmates may help you out.

## **Appendix 6 –Video Footage**

See CD



## Appendix 7 – Group 1 Results

Isolation of the ASQ results for Group 1 - those with negative CPCN score											
Student ID	CoNeg	CoPos	CPCN	Internal N	Stable Ne	Glob Neg	Int Pos	Stable Po	Glob Pos	Hopeless	Hopeful
7	15	12	-3	5	5	5	4	4	4	0	0
15	14	12	-2	4	5	5	4	5	4	0	1
19	14	13	-1	6	5	4	4	5	4	1	1
20	14	12	-2	5	5	4	4	4	4	1	0
25	18	12	-6	6	6	6	4	4	4	0	0
32	18	11	-7	6	6	6	4	3	4	0	-1
33	16	15	-1	5	6	6	5	5	5	0	0
34	13	12	-1	5	4	4	5	5	3	0	1
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
Student ID	Overall exp	internal/ext	fun?	Hard?	Altern math of help?	Alter fut view of math?	Help in exam?	Best thing	Worst thing	Comment	
7	good	50:50:00	lots	some	y	y	y	real-life qs	nothing	think on diff level, loved setting qs	
15	good	50	some	some	y	y	y	working with others	felt I was slow	fun way to learn	
19	good	50	lots	some	y	y	y	great fun	hard math	interaction with others and FUN	
20	good	50	some	some	y	y	y	nice approach	nothing	prefer to learn this way	
25	great	50	lots	some	y	n	n	look' of qs, interaction betn students	ans either right or wrong	when forum got busy, it was hard to locate postings	
32	good	me	some	all	y	n	n	think at diff level	more hints	message forum got very full	
33	good	50	some	some	y	y	y	posting qs and ans those of others		reat potentiatl. Visually engrossing.	
34	not so good	50	lots	some	n	n	n	real-life qs	prefer math class	enjoyed experience	

## Appendix 8 – Group 2 Results

Isolation of the ASQ results for Group 2 - those with CPCN scores of between 0 and 5											
Name\Que	CoNeg	CoPos	CPCN	Internal Ne	Stable Neg	Glob Neg	Int Pos	Stable Pos	Glob Pos	Hopelessn	Hopeful
1	10	12	2	5	3	2	5	4	3	1	1
4	14	17	3	5	5	5	5	6	6	0	0
5	15	15	0	6	5	5	5	6	5	0	1
6	14	14	0	3	5	5	4	5	6	0	-1
8	12	15	3	3	5	4	6	6	4	1	1
9	11	12	1	3	3	4	4	3	5	-1	-1
10	14	19	5	7	2	5	6	7	6	-2	1
12	12	15	3	6	4	3	5	5	4	1	1
13	12	15	3	6	3	4	6	5	5	-1	0
14	10	11	1	2	6	3	3	6	3	2	2
17	15	16	1	6	5	4	5	5	6	1	-1
18	11	16	5	5	3	3	5	5	6	0	-1
21	15	20	5	5	5	5	7	7	7	0	0
22	12	12	0	4	4	4	3	3	6	0	-2
23	12	17	5	4	4	4	6	5	5	0	0
27	12	12	0	4	4	4	4	4	4	0	0
28	12	14	2	5	4	4	6	4	4	0	0
29	15	18	4	4	5	6	7	5	7	0	-1
30	14	15	1	5	5	4	6	5	5	0	0
31	13	15	2	5	4	4	5	6	4	0	1
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
	Overall exp	internal/ext	fun?	Hard?	Altern math of help?	Alter fut view of math?	Help in exam?	Best thing	Worst thing	Comment	
1	great	50:50:00	lots	some	y	y	y	relax	hard math	good to work with others	
4	good	50:50:00	lots	some	y	y	y	easy to use, talking to others	hard math	v enjoyable. Nice way to learn math	
5	good	me	lots	some	y	y	n	helps you to think	hard math	needed more exposure to s/w	
6	not so good	50:50:00	some	some	n	n	y	relax	wording of qs	computer exp needed	
8	good	me	some	some	y	y	y	computer helps understanding	not enough time		
9	good	50	some	some	y	y	y	doesn't look like math	would like to be able to go back over qs answered	liked hints and would like more exposure	
10	great	50	lots	some	y	y	y	setting qs	no bad thing	great way to learn math and teach others	
12	good	50	some	some	y	n	y	commun with others	nothing	good exp	
13	good	50	some	some	y	y	y	different perspective, v enjoyable	thinking of qs for others	needed more exposure to s/w	
14	not so good	me	some	some	n	y	y	working with others	needed more time	needed more exposure to s/w	
17	great	me	lots	some	y	y	y	try again option and hints	nothing	v helpful for learning math, Fun	
18	not so good	50	some	some	n	n	n	online help from others	some qs worded strangely	good basis for exam study	
21	good	50	some	some	y	n	y	commun with others	hard math		
22	good	50	some	some	y	y	y	try again option and hints	hard math	v helpful for learning math, Fun	
23	good	50	lots	some	y	y	y	check own progress	bit confusing wording	will help me in exam	
27	good	50	some	some	y	y	y	able to re-do qs	hard math		
28	good	me	some	some	y	y	y	the tree	poor pc	decimal questions were ambiguous	
29	good	me	some	some	n	n	n	makes math fun	tree progress was slow	great exper	
30	good	50	some	some	y	n	y	real-life qs	nothing	good for exam	
31	not so good	50	some	all	n	n	n	forum great	moving betn paper and screen	allow for margin of error vs exact answers	

## Appendix 9- Group 3 Results

Isolation of the ASQ results for Group 3 - those with CPCN scores of 6 or greater											
Name\Que	CoNeg	CoPos	CPCN	Internal Ne	Stable Neg	Glob Neg	Int Pos	Stable Pos	Glob Pos	Hopelessn	Hopeful
2	9	16	7	4	4	2	7	6	3	1	2
3	11	17	6	4	4	4	6	6	6	0	0
11	6	12	6	4	4	4	4	4	4	0	0
16	6	14	8	3	2	1	5	5	4	1	1
24	12	18	6	5	3	4	6	7	5	-1	1
26	10	18	8	4	3	3	6	6	6	0	0
Student ID	Overall exp	internal/ext	fun?	Hard?	Altern math of help?	Alter fut view of math?	Help in exam?	Best thing	Worst thing	Comment	
2	good	me	some	some	y	y	n	interface and tree	hard math	nice change, more fun questions	
3	good	me	lots	some	y	n	n	variation to class	some bugs	great potential when used with conventional class	
11	great	me	some	all	y	n	y	sence of achievement - tree	hints could be better	start with easier qs, that get progress. Harder	
16	great	50	lots	some	y	y	y	great tool	nothing	easy to access	
24	not so good	50	some	all	n	n	n	colour and graphics	hard math	great idea if math were easier	
26	good	me	lots	some	y	y	y	interact with others and create own questions	cannot re-do an answered q	Fun, easy to be enthus	

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