

3 Research design

This chapter considers issues associated with the design of the research described in this thesis. First, the philosophy of the research is discussed in the context of educational research as a whole; then an overview is presented of the research techniques used; and the chapter finishes by considering the ethical issues associated with this research.

3.1 Research philosophy

Ontological assumptions, regarding the way in which reality is viewed, give rise to epistemological assumptions, about how the view of reality is studied, which influence methodology and, in turn, data collection and analysis methods. Therefore, the choice of research methods in education is more than a technical exercise but is concerned with understanding how the researcher views the world (Cohen et al, 2000). This section, therefore, takes cognisance of the fact that the world view and philosophy of the researcher can influence the approaches taken and conclusions drawn from the research, and provides an overview of the personal philosophy of the researcher and a discussion of the ways in which this might influence the research and measures that have been taken to counter this.

There are two contrasting philosophical approaches to research in the social sciences: positivism and relativism, the positivist approach being closely associated with quantitative research methods while relativistic approaches are associated with qualitative ones (Robson, 2003). The positivist, or scientific, approach to research views the nature of the world as existing regardless of people's perceptions of it, and that experiences can be described in terms of objective facts that are essentially value-free; hypotheses can be tested against these facts, and causal relationships can be demonstrated between events. This perspective takes no account of the fact that social science is involved with the understanding of human phenomena or cognisance of the nature of human perceptions.

Relativist approaches take the view that there are not absolute truths, but people have different ways of perceiving the world and that there is no external reality independent of the beliefs and perceptions of those experiencing it; the complexity of experience and behaviour must be studied to gain true understanding. The extreme relativist perspective “maintains that there is no external reality independent of human consciousness; there are only different sets of meanings and classifications which people attach to the world” (Robson, 1993, p 22).

In effect, positivism and relativism can be seen to represent two extreme world views. Pring (2004) describes a ‘false-dualism’ that exists in the belief that in rejecting the positivist perspective the relativist perspective must be unequivocally accepted. He argues that:

How we conceive things is embodied within a language and inherited by those who learn the language. Far from individually constructing the world, we acquire those constructions which (although socially developed) are possible because of certain features of reality which make them possible. It is not that there are multiple realities. Rather are there different ways in which reality is conceived, and those differences may well reflect different practical interests and different traditions. (Pring, p 52.)

The current approaches to research in social science tend to reflect this stance; while accepting that pure positivism is inappropriate for undertaking research with people, extreme relativism is equally unsuitable for envisaging reality. Robson (1993) describes three broad strands of current approaches to social and educational research: post-positive, constructivist and emancipatory. The post-positive view is that a reality does exist but that it can only be imperfectly known because of the limitations and biases of the researcher. Constructivist research (also called ‘interpretive’ or ‘naturalistic’) considers that the nature of reality is a social construction and that it is the role of the researcher to make sense of the multiple social constructions. Emancipatory research (e.g. feminist approaches) is critical of post-positive and constructivist approaches because it perceives relatively powerful experts undertaking research with relatively powerless people, and looks for ways to correct this imbalance.

The research described in this thesis is heavily influenced by the constructivist perspective and a belief that knowledge of the world can not be truly objective, but that meaning and understanding are constructed individually and that shared understandings can be reached through discussion with others. The philosophy of research implemented in this work stems from this, with a belief that educational research can never be entirely objective and that the nature of truth is influenced by those who perceive it. The types of data examined in this research reflect this philosophical viewpoint in that they focus on individuals' perceptions of their experiences, their feelings and beliefs.

While this thesis is based on a belief in the subjective, or individually constructed, nature of educational research, an equally strong belief is held that it is the duty of researchers to acknowledge and take account of, within appropriate ethical frameworks, the influence of the beliefs and values of the researcher on the implementation of the research methods and on the interpretation of the results. Although the data examined during this research are almost exclusively qualitative, focusing on the perceptions of participants, both qualitative (e.g. interview) and quantitative (e.g. Lickert questionnaire) data collection and analysis methods are used, with the aim of triangulating the findings of the research.

Above all, this thesis is underpinned by the belief that all research, whether it originates from a quantitative or qualitative tradition, should be carried out with rigour and integrity, acknowledging and understanding both its bias and its limitations. The following section details the research methods used to address each of the research questions described in Chapter 1.

3.2 Research techniques

This section provides an overview of the research techniques used for addressing each of the four research questions, and a rationale for each of the techniques used.

The research draws on both quantitative and qualitative data collection and analysis techniques and these are described in more detail in the sub-sections that follow.

3.2.1 Is there a rationale for using computer game-based learning in Higher Education?

The first research question considers the reasons for using computer game-based learning in Higher Education and what the potential benefits might be. Two stages were undertaken to answer this question: first, fact finding about the nature of the domain of computer game-based learning, in-depth and on a small scale, and secondly, testing these findings on a larger scale. The data collection and analysis techniques used to address this question are summarised in Table 3-1 below.

Questions	Data collection	Data analysis
<p>How does the concept of game-based learning in the literature match people's perceptions?</p> <p>What factors motivate people to play games for leisure and learning?</p> <p>Is game-based learning seen as an acceptable way to learn?</p>	Interviews	<p>Thematic analysis</p> <p>Categories of description</p>
<p>How generalisable are these findings to a population?</p> <p>Is there a link between motivation to play games for leisure and motivation to play games to learn?</p>	Survey	<p>Descriptive statistics</p> <p>Chi-squared (X^2) analysis</p>

Table 3-1: Data collection and analysis techniques used to consider the rationale for using computer game-based learning in Higher Education

A series of 12 in-depth interviews with students and ex-students in Higher Education was used as the starting point for this research. It was important to ensure that the concept of game-based learning used in the academic literature matched the perceptions of those people in the population under study, so that the participants and researcher were, in effect, talking a common language. In terms of establishing a rationale for the use of game-based learning, the research explored people's motivations for game-playing both for recreation and leisure and, more fundamentally, to establish whether the use of game-based learning in Higher Education would be seen as an acceptable way to learn. Semi-structured interviews with open-ended questions were used for the first part of this research because the aim was to explore the field of study and the individual perceptions of that domain. The interviews used to initially explore

people's conceptions of game-based learning were based upon the phenomenographic methodology designed to explore individual perceptions of a phenomenon. The interviews were analysed by drawing out themes, and by creating and testing categories of description (Marton, 1981; Marton, 1986). The phenomenographic method was selected because its outputs of categories of description were considered to be an appropriate tool for understanding how different people perceive games and game-playing, which could usefully inform further stages of the research.

In order to test the findings from these interviews on a larger scale and, in particular, consider whether there is any link between motivation to play games for leisure and to learn from games, a larger-scale survey was undertaken with 200 undergraduate and postgraduate students. This survey was used to collect quantitative data on game-playing habits, motivations and preferences, as a practical way of testing the findings from the initial interviews with a larger population. It was analysed using descriptive statistics to present an overview of the data and a X^2 (chi-squared) statistical analysis to examine if there was any relationship between a motivation to play games recreationally and a motivation to learn using games. A X^2 test was appropriate because the data were nominal, that is, the students could be categorised as motivated to learn with games, not motivated either way, or de-motivated (Greene & D'Oliveira, 1993).

More detail about the methods used to conduct these interviews and survey, the results of the analysis and the conclusions drawn can be found in Chapter 4.

3.2.2 How best can computer games be designed to be usable and enhance learning?

The second research question examines some of the practical and design issues associated with the development of game-based learning. To answer this question, three areas were addressed: first, the development of criteria to evaluate aspects of game-based learning; second, an analysis of the appropriateness of different game types to game-based learning; and third, a consideration of the usability issues associated with the design of the two game-based applications created as part of this research. A summary of the data collection and analysis methods used is given in Table 3-2 below.

Questions	Data collection	Data analysis
What criteria can be used to evaluate the extent to which an educational computer game embodies sound educational principles? What criteria can be used to evaluate the extent to which an educational game is usable and fit-for-purpose?	Review of secondary sources. Review of existing games.	Synthesis of existing guidelines. Analysis of game design for usability and learning.
What types of game are most appropriate for learning? What activities in Higher Education are most appropriate to be taught with games? Can two specific educational games be designed to include sound educational principles?	Review of literature on games and learning.	Mapping of game characteristics with educational characteristics. Evaluation of game design against learning criteria.
How can the playability, functionality and interface design of two specific computer-based games be improved?	Walkthroughs. Focus groups. Observation.	Categorisation of issues. Evaluation of game against usability criteria.

Table 3-2: Data collection and analysis techniques used to consider how best computer games can be designed to be usable and enhance learning

In order to develop criteria for evaluating the effectiveness of particular computer games for learning, two specific areas were examined: the educational principles embodied within the game and the usability of the game. These criteria were produced by synthesising findings from a review of secondary sources with first-hand data collected from a review of online games. Much has already been written regarding the development of usable and effective educational games, so it was important to review existing research first as a starting point. This was augmented by undertaking a review of online games, for two reasons: first, the development of computer games is a fast-moving field and the games available at any time are likely to be ahead of the published literature; and second, this review provided the opportunity to become immersed in the range of online games available and to generate ideas for the game design and development undertaken. The purpose of developing criteria was to inform and support the game design and development process and enable explicit evaluation during the development process. A full description of the development of evaluative criteria can be found in Chapter 5.

The second area addressed by this research question was which types of game are most suitable for learning and what types of skill or knowledge are most appropriate to be taught using games. The literature review undertaken in Chapter 2 provides a starting point for considering the genres of game that have most potential for learning and the types of skills or knowledge that might most appropriately be taught with games in Higher Education. This provides a rationale for the design of the two game-based learning activities described in Chapter 6, which are then evaluated against the criteria for effective design for learning, as an indicator of their efficacy.

The final aspect of this research question looked at two specific instances of game-based learning (the Time Capsule and Pharaoh's Tomb applications) to determine how game play, the functionality available and the interface design could be improved. A range of data collection methods were used to evaluate the usability of the two activities created because this supported triangulation of the issues collected. Walkthroughs of the applications enabled the participants to talk through their experiences individually, while focus groups gave them the opportunity to discuss their experiences with others and collectively brainstorm and problem-solve solutions, and observations provided indications of behaviour that were sometimes not all that apparent to the participant when immersed in the experience. Findings from the usability studies were categorised and used to address and resolve usability issues. There is an extensive description and discussion of this stage of the research in Chapter 7.

3.2.3 How can the educational effectiveness of computer game-based learning be measured?

This third research question is concerned with ways in which the educational effectiveness of game-based learning could be measured. This involved three separate methods of collecting evidence of learning: the development of a questionnaire to measure engagement; an experiment to compare learning between face-to-face and online versions of the same activity; and an analysis of transcript data to provide evidence of learning. An overview of the data collection and analysis techniques is given in Table 3-3.

Questions	Data collection	Data analysis
How can post-experience engagement be measured with a questionnaire? How can it be ensured that the questionnaire is reliable?	Questionnaire piloting	Kendall's Tau correlation Discrimination power
Is a specific online activity as effective as an equivalent face-to-face one?	Questionnaire	Fisher's exact test
Is there evidence of learning from a specific online activity?	Transcripts	Content analysis

Table 3-3: Data collection and analysis techniques used to consider how the educational effectiveness of computer games might be measured

For reasons discussed in Chapter 8, this research was not primarily concerned with measuring learning as such but with measuring the levels of engagement experienced during an activity. In order to do this, a Likert attitudinal questionnaire was developed to measure engagement. A version of the engagement questionnaire with 42 questions was piloted with 33 participants and was then analysed using a combination of a Kendall's Tau correlation analysis (used to measure correlations between ordinal data) between questions that were supposed to be measuring the same factors, and the discrimination power statistic of each question (Robson, 2002). Those items that were less effective at measuring the intended concepts were removed and a final 18-question questionnaire was developed.

Likert-style questionnaires are commonly used to gather opinion in the field of education, but there are two issues with their design and use. First, it is often the case that questionnaires are developed and used with minimal piloting, statistical analyses, or refinement of questions; second, these type of questionnaires are often analysed inappropriately by assigning a numerical value to each response and using parametric comparative statistics. A major contribution of this work is the production of an attitudinal scale that has been rigorously developed and tested, with an example of analysis using appropriate statistical techniques.

In addition to developing a tool to measure engagement, a self-report learning questionnaire was produced and used to evaluate differences in learning between a face-to-face version of the Time Capsule activity and the online

version. This aimed to provide evidence of the comparative effectiveness of the two activities for learning. Fisher's exact test was used because the data being compared were nominal and could be categorised (i.e. the students were asked to say whether they felt that their learning in an area had increased or whether it had not) but the distribution of expected values meant that a X^2 test was not appropriate in this situation.

Finally, to provide another perspective on the evaluation of learning, as well as evidence for the suitability of the two learning games produced, transcripts from the trials of both the online Time Capsule activity and the Pharaoh's Tomb activity were collected and analysed. This analysis involved scrutinising the content of the transcripts to find evidence of learning, collaboration, and creative problem-solving.

Further detail and descriptions of this section of the research, the methods employed and the results of the analysis can be found in Chapter 8.

3.2.4 How do differences in game design affect the learning experience?

The final part of this research examines the use of two different types of game-based learning activity in a comparative experiment and evaluates the differences in learning and engagement between the two experimental groups. A summary of the data collection methods and data analysis techniques is provided in Table 3-4.

Questions	Data collection	Data analysis
Is there a significant difference in learning between students in each experimental condition?	Self-perception of learning questionnaire	Chi-squared (X^2) analysis
Is there a significant difference in engagement between students in each experimental condition?	Engagement questionnaire	Mann–Whitney test

Table 3-4: Data collection and analysis techniques used to consider how differences in game design can affect the learning experience

Three experimental studies were carried out to address this final research question: two pilot studies (with 15 and 17 participants) and a final study with 79 participants.

In each study the students were split into two groups; approximately half used the Time Capsule activity and half the Pharaoh's Tomb, and at the end of the game they were asked to complete a self-reported learning questionnaire and an engagement questionnaire. The pilot studies aimed to test the software under conditions of many subsequent users and ensure that the games, supporting materials and questionnaires were usable in a teaching situation.

The self-reported learning questionnaire was used as a method of testing what had been learned from completing the activities. For reasons discussed in Chapter 8, this style of questionnaire was used rather than a more usual pre-test/post-test design for measuring learning. Once again, X^2 was used as analysis technique for determining whether there was a significant difference in responses, because the questionnaire asked whether the students perceived they had increased their skills in an area or not (i.e. the students' responses can be categorised).

Engagement with each of the activities was measured with the 18-question Lickert questionnaire that was developed in an earlier stage of the research. The responses to this questionnaire were analysed using the Mann–Whitney test to determine whether there was a significant difference in engagement between the conditions, overall and also in terms of the factors that contribute to engagement. As the responses to the questionnaire were ordinal, the Mann–Whitney test is an appropriate non-parametric statistical test to use when a single variable is being analysed with different participants in two experimental conditions (Greene & D'Oliveria, 1993).

As can be seen from previous sub-sections, a range of different qualitative and quantitative data collection and analysis techniques have been used as part of this research. What the overview in this chapter aims to provide, as well as a summary of methods employed, is evidence of triangulation throughout, where more than one research method has been used to contribute to answering each of the research questions in this thesis, within the practical and ethical limitations of the research. The final section of this chapter considers the ethical issues associated with the research.

3.3 Ethical issues

In this section, the ethical issues that were considered while undertaking this research are discussed, along with the decisions made and the implications of those decisions. The BERA (2004) ethical guidelines for educational research were used as a guiding set of principles that informed this work.

Denscombe (2002) says that it is an important, but easily overlooked, point that any research within a social context should be morally and legally acceptable; that is, it does not break the law and it respects the cultural norms of the society in which it operates. It is affirmed that the research described in this thesis is morally appropriate and does not break the law in any way. It should also be made clear that the researcher is committed to undertaking research with integrity by undertaking and presenting research as faithfully and honestly as possible.

A small amount of funding was received from Manchester Metropolitan University to provide incentives for participants but this was in no way tied to any expectations regarding the research. Other ethical issues are considered under two headings: the rights and interests of the participants; and the issues of informed consent.

3.3.1 Rights and interests of the participants

It is the right of any participant in research to take part knowingly and not to be deceived or have information misrepresented about any aspects of the research, although occasionally a level of deception might be necessary for the research. In the case of four of the participants of one of the usability tests, because there was only one evaluator available, it was necessary for the participants to believe that they were playing the games with two people remotely when in fact there was one person in the next room acting in both of these roles. It was felt that the level of deception was minimal and therefore acceptable in this situation; at the end of each evaluation the participants were debriefed and met the other player. Apart from this one instance, no deception was felt to be appropriate in the case of the research described here, and every effort was made to be as open, honest and transparent as possible.

Research should not discomfort, cause pain or mental stress to the participants (Denscombe, 2002). While it can not be a hundred per cent guaranteed that no participant felt uncomfortable or stressed while undertaking the research, the voluntary nature of participation throughout (see the following sub-section for more detail) and the open way in which the research was conducted and discussed with participants should have helped to put participants at their ease.

The right to privacy of the individuals taking part was also considered, in particular, issues of confidentiality, anonymity and data security. Participants were made aware that all data are treated as confidential and although publications may be generated from this research all results would be presented anonymously and no individual would be able to be identified. All original paper data collection instruments are kept securely and all electronic data, questionnaire results and interview transcripts, are anonymised and stored on a secure computer.

It was also important that at no point was taking part in this research detrimental to participants. This is particularly relevant when alternative experimental conditions were used as a required part of a programme of study, as in the case of the comparative study testing learning between paper-based and online versions and those comparing the Time Capsule and the Pharaoh's Tomb. In all cases there was no reason to believe in advance of the experiment that one experimental condition would benefit the group undertaking that condition more than the other, and it is felt that all groups would have an equivalent educational experience. Where the research took place in scheduled teaching sessions, it was ensured that the learning outcomes of the curriculum matched the learning outcomes of the games used and that there was minimal disruption and class time spent undertaking the research (e.g. completing questionnaires).

3.3.2 Voluntary informed consent

BERA (2004) describe voluntary informed consent as “the condition in which participants in the research understand the process in which they are to be engaged and agree to their participation without any duress, prior to research getting underway” (p 6). In an ideal world, participants would be provided with printed information in advance and be asked to sign a consent form before

undertaking any research; for pragmatic reasons this was not always possible during this research, although it was ensured that all participants were informed about the nature of the research, and made aware of their rights not to participate and to withdraw from the research at any time.

In total, 443 participants took part in various stages of the research. Table 3-5 shows a summary of their involvement, the number who took part in each stage of the research and how they were recruited to take part.

Group	Involvement	Number	Recruitment method
1	Interviews	12	Word of mouth
2	Questionnaires	200	Lecture attendees
3	Usability evaluations	27	Word of mouth
4	Questionnaire pilot	33	Email recruitment
5	F-2-F / online comparison	60	Tutorial attendees
6	Pilot study 1	15	Email recruitment
7	Pilot study 2	17	Tutorial attendees
8	Final study	79	Tutorial attendees

Table 3-5: The groups of participants involved during this research, the nature of their involvement, number and recruitment method

Participants taking part in groups 1 and 3 were recruited by word of mouth and volunteered to take part in the research. All of the participants were informed about the nature of the research and their part in it before they agreed to take part, and because the people involved in these stages of the research spent time in individual contact with the researcher there was ample opportunity for discussion and clarification regarding the research, although they were not provided with written information or asked to sign a consent form.

Students in group 2 were asked to complete a background questionnaire at the end of a lecture. They were given a short talk about the research, provided with the opportunity to ask questions, and asked to complete an anonymous questionnaire. Completing the questionnaire was voluntary and it was not possible to tell which students had or had not completed it, so it is felt to be unlikely they would feel coerced in this situation. While the response rate was

high, it was not absolute so there were some students who chose not to participate.

Participants in group 4, the questionnaire pilot, were recruited by email and undertook the research remotely. The initial email provided written information on the study and those who responded volunteered to take part. A small number of the original participants withdrew from or only partially engaged in this stage of the research, in all cases citing pressure of time. These participants were thanked for their contribution to the research and assured that withdrawal was an acceptable decision for them to make.

Initially, for the first pilot study, group 6, incentives of book tokens were offered to students, which were felt to be appropriate and commensurate with the amount of effort required. These participants were informed by email of the nature of the research and asked to sign a form showing that they consented to taking part in the research. However, the tokens offered did not prove to be enough of an incentive to recruit the requisite numbers of participants so an alternative recruitment strategy was adopted for the other experimental studies.

The students in groups 5, 7 and 8 took part in the research as part of their programme of study, so their engagement in the process was not entirely voluntary. In these cases the learning applications were used as part of normal teaching, as their learning outcomes matched those of the curriculum at that stage. It would not have been appropriate to allow these students not to participate in learning activities that were part of their course, but they were given the option not to participate in the aspects relating to the research (e.g. completing the questionnaires). In all of these cases there were severe time limitations and it was simply not practical to distribute written material and consent forms; however, in each case the students were given a short presentation on the research, provided with the opportunity to ask questions and made aware of their right not to take part in the research.

During these sessions, the researcher was leading the class so would have been perceived in the role of a teacher; it is possible then that some of the students may have felt compelled to complete the questionnaires, despite

reassurances that participation was non-compulsory. This is a difficult ethical issue that occurs when undertaking research in genuine classroom settings. In the case of this research it was felt to be a justifiable risk as the difficulty in recruiting participants voluntarily meant that there was little option but to undertake the experiments during scheduled teaching sessions.

This chapter has considered the philosophical standpoint that underpins the research described in this thesis; it has restated the research questions and described and attempted to justify the data collection and analysis techniques that were used at each stage of the research to answer these questions; finally the chapter presented a range of ethical issues that were considered as part of this research. The next chapter starts to describe in detail the original research carried out by presenting the initial interview and survey data used to address the question of rationale for game-based learning.