CHAPTER III

RESEARCH DESIGN

In this chapter the researcher will elaborate on and attempt to justify the research methodology utilized in order to conduct the current study. Details of the adopted research design, sampling procedure, location, data collection, data mining, data analysis, and procedures followed consecutively in drawing the stated results and conclusions are explained. As the study was conducted in a school context observing students, teachers and taking field notes along with interviewing and observing these informants, the chapter will elaborate the details of these steps/phases of research.

The research instruments are introduced and their measures of dependability are mentioned as well. Last but not least, the issues of validity and ethics are treated in the final section of the chapter.

Method

The purpose of the current study is to provide an in-depth understanding of chemistry teaching by using computer-based activities in the 11th grade of the Iranian high schools. Therefore, the focus is on the elements of the teachers' roles, students' roles, and the interactions between them, the advantages and issues associated with technology-mediated learning, and the student learning outcomes.

Based on an in-depth understanding of these roles, interactions, and outcomes, the study explored the new teaching style for teaching chemistry. Consequently, this research has utilized the naturalistic study of strategy in education (Guba & Lincoln, 1983) where the research site was on computer-based activities rather than in a traditional classroom setting.

This study was organized into three phases. The first phase was to understand the current pedagogical practices in the classroom. The second phase was to describe and examine the influencing factors that impact teaching practices. The third phase was to identify the essential features of teaching chemistry through computer in the high schools.

The Delphi technique was utilized in the third phase in order to achieve the experts' consensuses upon the proposed development. The result is developed into a pedagogical model for chemistry classes in Iranian high schools. As far as research typology is concerned, this study was naturalistic, therefore, it needed a phase of triangulation of data in order to verify the conclusions achieved. Triangulation is typically a strategic test for improving the validity and reliability of research or evaluation of findings.

Mathison (1988) has elaborated that triangulation has risen as an important methodological issue in naturalistic and qualitative approaches as it controls bias and establishes valid propositions.

Patton (2002) also believes that the use of triangulation strengthens a study because it combines methods. Thus, both naturalistic and qualitative data were collected to gain a holistic vision of ICT in Iranian schools. Using this approach we were able to gain a rich description of the current issues of pedagogical practices, understandings, use of resources, and student

products. Details of the triangulated data sources are managed in this chapter.

Moreover, this chapter describes and explains the sample, and the instruments used to generate data that answer the research questions outlined in Chapter One. The two most important elements in this research are observation and interviews.

Some other features, which were investigated by the researcher, were pedagogical practice, a suitable level of high schools to find out the important aspects of their goals, and the infrastructure and other related initiatives in schools. These elements of potential influence are elaborated on as well. Following this brief introduction of the research methodology, the researcher will explain the steps and phases of the current research.

Observations and Interviews in Classroom

Phase 1 involves observations and interviews in the classroom. This section describes the typology of the collected data (nature of data), the data collection procedure, as well as the teachers, the students, and their interactions while technology is being used in the classrooms. The objective of this phase is finding problems for future development.

Sample. The most important objective of this study is set on developing an in-depth understanding of "pedagogical practices" with the use of computers in teaching chemistry. The samples for the current study have been adopted based on the purposeful sampling technique (Patton, 1990). In doing so, a considerable effort is devoted to selecting cases that

would provide a variety of worthwhile data reflecting the widest range of teaching approaches present in the Iranian schools.

However, as the teaching approach used can only be determined after the actual observation of the classroom interactions, the actual case selection was also made initially at the school level. This diversity in the type of schools is important as different schools have different levels of access to computers that would necessarily affect technology implementation in the school curriculum.

In order to arrive at a list of potential schools for the study, the researcher consulted the Education Department officials who have worthy contacts with schools. In addition, there were publicly available information sources such as newspapers that helped identify schools that were actively engaged in some form of computer integration in their school curriculum. The researcher then contacted the school principals and asked if they would be willing to give permission to conduct the research in their schools. The key criterion for selection at this stage was that the researcher should be allowed to observe some chemistry classes (minimum of one), where a computer is being used, and that the researcher could videotape the lesson while it was being presented.

The chemistry classes to be observed were decided after discussions and negotiations with the school principal. The researcher finally selected 10 high schools from a diverse range of backgrounds and schools that had various kinds of computers used in their classrooms. Each school had one computer laboratory with 10 desktop computers per lab that were networked

to a central server. Broadband Intranet access in the form of “School Net” was available.

However, printing facilities were only accessed by teachers. In addition, each school had an average of one video projector and an ICT team. It was realized that all teachers had experienced some computer usage during their teaching. A summary of this sample data is depicted in Table 3.1.

Table 3.1

Summary of Sample Data

Schools	Interviews	Classroom observation	Student interviews
Zohreh Hadikhn Tehrani	Teacher Shahin Principal Tahereh ICT team Faezeh	Year 2	3 students
Somayeh	Teacher Soodabeh Principal Sakineh ICT team Atousa	Year 2	3 students
Safai Asfahani	Teacher Sedigheh Principal Zohreh ICT team Fataneh	Year 2	3 students
Shayestegan	Teacher Mandana Principal Fereshteh ICT team Asmat	Year 2	3 students
Narges	Teacher Mandana Principal Fatemeh ICT team Safieh	Year 2	3 students
Saba	Teacher Laleh Prrincipal Moazam ICT team Masoomeh	Year 2	3 students
Farhang	Teacher Roghayeh Principal Tooran ICT team Shadi	Year 2	3 students
Ferast	Teacher Afsaneh Principal Tahereh ICT team Shahala	Year 2	3 students

(Table 3.1 continued)

Schools	Interviews	Classroom observation	Student interviews
Narges	Teacher Ladan Principal Zhila ICT team Maryam	Year 2	3 students
Shahid Mahdavi	Teacher Mooghgan Principal Shadi ICT team Noushin	Year 2	3 students

Note. All names are pseudonyms.

School selection procedure. For the purpose of conducting the naturalistic study ten schools were finally nominated. The selection was based on the recommendations of the Ministry of Education, various school networks, and formal educators. These schools had the most innovative usage of computers based on the available records. The classroom times ranged from 75 to 90 minutes in duration. On the basis of the type of school (governmental, private, etc.) which would have influenced the design, implementation, and impact of technology application to the routine class activities, the researcher made an effort to select the targeted high schools. Moreover, the application of the defined selection criteria was another selection measure (i.e., which school has utilized the ICT technology in practice). Eventually, the selection measures were decided based their current use of ICT. Schools selected had the following characteristics of ICT use: 1) should show evidence of significant changes in the roles of teachers and students, the goals of the curriculum, assessment practices,

and/or the educational materials or infrastructure, 2) must play a substantial role in these schools, 3) should demonstrate evidence of measurable positive student outcomes, 4) is sustainable, transferable, and scalable, and 5) is innovative.

Data collection procedure. As soon as schools confirmed their voluntary participation in the study, the researcher requested a list of documents required to precede the research. Before the actual visits, the researcher had to read some general information to gain as much background as possible about the school. Usually, the school visits were made upon agreement between the school principal and the teacher. However, school visits were made for two purposes: data collection pertaining to the lesson observations, and understanding of the school context, in particular the implementation of computers.

Lesson observation was conducted by the researcher, who was also responsible for recording video footage. Details of the data collection and instrumentation used are described later in this chapter. In each school one chemistry lesson was observed. To maximize the use of time, the researcher elicited information pertaining to the school context and the implementation policies before or after observation of the lesson. To complete a case study, the researcher had to spend two to three days in each school. The data collected included: 1) observations of the lesson, and 2) notes taken during the interviews with students and teachers.

***Teacher interviews*.** Silverman (1993) stated that interviews are social events based on mutual participant observation. Concerning the interference of interviewer's analysis the researcher needed to allow the interviewee to answer their questions as freely as they wished. The interview questions needed to be studied before they were tried (Moseley et al., 1999). The interview included: 1) The pre observation to find out about the lesson objectives, the planned activities, and the role of computers, 2) The post observation to obtain students' behavior, the problems in lesson preparation, and their needs. Hopkins (2002) recommends that discussion in classroom observations should take place as soon as possible and that interpretation from the teacher should be sought in a two-way discussion. The researcher followed those recommendations and used pre and post interviews. Each of those phases included 20-30 minutes and all the questions (noted in Appendix D) were asked directly. The researcher conducted face-to-face interviews with 10 teachers over 2 months. The list of semi – structured interviews is presented in Table 3.2.

Table 3.2

The List of Semi-structured Questions Used for the Interviews with Teachers

Contextual category	Main categories	Questions	Location/Target
School environment	Pedagogical practice	1. Is computer useful in your teaching? 2. Which aspects do you find most useful? 3. What is the role of computer in teaching these objectives? 4. In your opinion, do students behave differently when computer is used in class? If yes, please explain more? 5. Are there any problems to prepare the lesson? If yes, what are they? 6. What kind of training/ professionalism related to computer have you received? What further professional development would you need?	Teacher

***Observations*.** The purpose of this phase was to probe deeply and build up an in-depth understanding on teacher roles, student roles, and interactions between them in classroom activities and technology usage. The researcher had asked the following questions in favor of deeper probe: "What were actually happening in those classrooms?", "Did the utilized ICT (particularly computers) have any direct or indirect influence on the students' critical thinking?" This phenomenon has been addressed in Squires and McDougall (1994) on the using of ICT in the educational system, which includes three-way interaction between learners, teachers and computers while considering the wider context in which teachers and learners work.

Cartwright and Cartwright (1984) stated that high inference potentially reduces reliability because observers may gain a halo effect. Therefore, observers need to avoid any impact and focus on events. During this phase, however, the researcher used an unstructured observation schedule which was "observer as participant" (Birley & Moreland, 1998). The technique granted more success compared to a structured schedule as it ended up with a description of the different teaching styles of subjects that had been taught. Classroom activities and interactions between the teacher, the student and computer were recorded completely on video tape for better analysis. This videotape provided valuable information with conversations between the teacher and classroom activities. The video tapes were transcribed word-by-word into a word-processed format. Consequently, the categories of analysis of observations, as defined in Appendix B, provided a small transcript.

Student interviews. Before observing the lesson, the researcher asked the teacher to invite a group of 3 students to conduct a focus-group interview after the lecture. The purpose of the interview was to seek students' views on whether the activities and the particular use of technology during their lessons were interesting and effective.

The analysis of interviews as defined in Appendix C provided a short transcript. The list of semi-structured questions for this interview is displayed in Table 3.3.

Table 3.3

The List of Semi-structured Questions Used for the Interviews with Students

Contextual Category	Main Categories	Questions	Location/Target
School environment	Student	1. Is the use of Internet/ computer helpful in your learning? 2. Which computer program do you use for your assignment? 3. What uses of computer would you need to make in completing this assignment? 4. When facing the problem while doing the homework, who do you refer to? 5. Where did you learn your current computer skills and knowledge of computer programs? What are the major obstacles in learning with computer? Other comments (you are free to use the other side of this sheet).	Student

Analyzing. The observations and interviews were recorded and transcribed. According to Kvale (1996) the analysis of the written protocol needs a structure that includes certain phases such as: using the categorization of meaning, meaning condensation and meaning through narrative.

However, for the interview and the observation protocols the data was interrogated and the analysis followed these three themes: 1) the planning by the teacher and his goal, 2) the teacher roles, the students' roles, and the interaction between them, and 3) the roles of technology in classroom activity and how teachers use computers to teach. The themes were planned in a threefold perspective so that within each theme the

researcher was able to trace: 1) curriculum, 2) pedagogy (classroom interactions), and 3) outcome. These themes were then examined extensively to identify similarity and differences of the activities. A complete analysis of the data along with the related audit trail contents is available in Chapter Four.

Interviews with Principals and ICT Teams

In this research Phase 2 involves interviews with the principals and ICT teams in the selected schools.

Data collection in the school context and computer implementation.

The second phase of the research was planned to identify factors that affected pedagogical practice at the classroom level. In order to explore the sustainability and transferability of the pedagogical practices and their current implementation in the school, it was necessary to study the school context (Kozma, 1999). As discussed earlier, the implementation of computers in teaching and learning should be studied within the school context as an educational innovation. Thus, it is important to study the vision and mission of the school, the general perception by the school principal and staff, the roles and functions of computer in education and the school's computer implementation strategy and plan. For this purpose, the researcher requested the school (where classroom observations of pedagogical practices were conducted) to provide specific documentation about the school as well as the opportunity to conduct interviews with the

principal and the ICT team members. The general scheme of the collected information is presented in Table 3.4.

Table 3.4
Structure of the School

School	
School Strategy	- Vision and mission of the school - ICT implementation in the school - ICT infrastructure available - Development plan and access policies - Technological infrastructure required - Support provided by the school in lesson implementation

Principal interviews. Fullan (1993) had foreseen that a change in instructional practice will occur in the culture of teaching toward greater collaborative relationship among teachers, students, and other potential partners. These elements are functioning in their natural hierarchy from the principal to the students consecutively. The principals of schools are known as being one of the important factors in the context of educational change (Leithwood, 1994).

Therefore, interviews with the school principals provided an opportunity to know the principals' views about the schools, the development of teachers and staff, the ICT developments in the school, and the possible difficulties of implementation of ICT in that particular school. The interviews were transcribed. The list of semi structured questions for these interviews is shown in Table 3.5.

Table 3.5

The List of Semi-structured Questions Used for Interviews with Principals

Contextual Categories	Main Category	Questions	Location/Target
School environment	Principal	1. How is this view on education manifested in your school? 2. What plan do you have in your school? 3. What challenges have you made in relation to education in your school? 4. You received large sum of budget for your school, what will your priorities be? 5. What factors encourage you to use ICT in your school?	Principal

ICT Team interviews. The ICT team has an important role in developing and using ICT as: 1) a tool for teaching and learning, and 2) as a Key Skill. The ICT team is expected to possess a broad vision of the ICT potentials across the curriculum and to work productively and sensitively with a wide range of staff to develop their teaching style.

Furthermore, the ICT team is expected to coordinate policies, work schemes and assessment related to ICT. An interview was arranged with the ICT team to determine: 1) the structure of the team and its key functions, 2) the roles of team members, the perceived achievement and general level of ICT usage by teachers and students, and 3) their plans for further development and their perceived key obstacles to the team's work. The interviews were transcribed. The list of semi-structured questions for this interview is displayed in Table 3.6.

Table 3.6

The List of Semi-structured Questions Used for Interviews with ICT team

Contextual Category	Main Categories	Questions	Location/Target
School	ICT team	1. How many staff work as ICT team in your school? 2. How many computers are there in your school? What are their hardware and software specifications? 3. What kinds of software are available in the school? Are they designed for educational purposes? If yes, what kinds of educational software are available? 4. What mode of usage has ICT been put to in the school for teaching and learning? 5. What further developments are being planned for the future? 6. What major difficulties and challenges are there for the ICT team in your school?	ICT team

Modified Delphi Technique

The third phase was a modified Delphi study. The purpose was to identify the essential features of teaching chemistry through computers in high schools. A panel of experts participated in a three-round Delphi process designed to identify these essential features. Included in this phase is a discussion of the research method utilized and its application to the current study, a discussion of how the study participants were assigned and/or selected, an explanation of how the survey instruments were designed and implemented, and a description of the data analysis procedure.

However, the researcher has deployed a modified Delphi process to first elicit and then rate the essential features of teaching chemistry through computers in high schools.

Background of the Delphi technique. The Delphi survey technique was developed in the 1950s by two research scientists working at The Rand Corporation, Olaf Helmer and Norman Dalkey. They developed the procedure as a tool for forecasting future events using a series of intensive questionnaires interspersed with controlled-opinion feedback (Chia-Chien Hsu & Sandford, 2007). The object of the Delphi method is to obtain a reliable response to a problem or question from a group of experts. This is done by giving individuals in the group a series of questionnaires (or interviews) that reiterate the same questions while providing group feedback from previous rounds.

The Delphi begins with an open-ended questionnaire that is given to a panel of selected experts to solicit specific information about a subject or content area. In subsequent rounds of the procedure, participants rate the relative importance of individual items and also make changes to the phrasing or substance of the items. Through a series of rounds "traditionally conducted in four rounds, can be done with more or fewer rounds, depending on the information needed" (Delbecq, Van de Ven, & Gustafson, 1975), the process is designed to yield consensus.

However, Delphi technique is based on the qualities of "anonymity, statistical analysis, and feedback" (Chia-Chien Hsu & Sandford, 2007). Anonymity is achieved through the use of questionnaires. By allowing the individual group members the opportunity to express their opinions and

judgments privately, undue social pressures, as from dominant or dogmatic individuals or from a majority, would be avoided. Ideally, this should allow the individual group members to consider each idea on the basis of merit alone, rather than on the basis of potentially invalid criteria (such as the status of an idea's proponent).

Furthermore, with the iteration of the questionnaire over a number of rounds, the individuals are given the opportunity to change their opinions and judgments without fear of losing face in the eyes of the (anonymous) others in the group. Between each questionnaire interaction, controlled feedback is provided, through which the group members are informed of the opinions of their anonymous colleagues.

Feedback is often presented as a simple statistical summary of the group's response, usually comprising a mean or median value, such as the average 'group' estimate of the date by when an event is forecast to occur. Occasionally, additional information may also be provided, such as arguments from individuals whose judgments fall outside certain pre-specified limits. In this manner, feedback comprises the opinions and judgments of all group members, and not just the most vocal ones. At the end of the polling of participants (i.e., after several rounds of questionnaire iteration), the group judgment is taken as the statistical average (mean/median) of the panelists' estimates on the final round. Thus, the final judgment may be seen as an equal weighting of the members of a static zed group.

Therefore, the decision to utilize the method is further supported by the fact that the Delphi applications are considered appropriate in situations

where the problem either has no monitored history, nor adequate information on its present and future development, or does not lend itself to analytical techniques. In these conditions, they benefit from subjective judgments on a collective basis where the exploration and assessment of numerous issues connected with various options are required (Linstone & Turoff, 1975).

Nonetheless, this technique is considered appropriate for the present study, which seeks to identify priorities, solicit a diversity of expert opinion, judgments and assumptions and determine possible alternatives pertaining to the evaluation for development of a pedagogical model for teaching of the chemistry subject. The outcome of the research will provide those criteria to be included in a drafted evaluation framework, which will subsequently be tested in a series of in-depth semi-structured interviews.

Advantages of the Delphi technique. Dalkey (1972) stated that the advantages of using the modified Delphi technique include reducing the effects of bias due to group interaction, assuring anonymity, and providing controlled feedback to participants. As noted by Helmer (1983) one of the advantages of the Delphi technique is that the expert participants are more likely to generate reasoned, independent, and well-considered opinions in the absence of exposure to the "persuasively stated opinions of others". Because the experts do not ever participate in a face-to-face discussion, there is no danger of one or more individuals' opinions being swayed by a more dominant or more experienced individual. Therefore, the advantage of the Delphi technique is its efficiency, validity, isolation of respondents,

experts' consensus, and flexibility, especially in light of modern communication technologies such as e-mail and the Internet.

Limitations of the Delphi technique. According to Delbecq et al. (1975), Delphi should not be used when any of the following three critical conditions are not present: adequate time, participant skill in written communication, high participant motivation.

Linstone and Turoff (1975) noted that participant dropout can be a problem in Delphi studies. They suggest that failure to allow participants to adequately contribute their own perspectives to the problem or issue at hand or failure to properly recognize or reward participants can negatively impact the results. They believed that the problem of bias in Delphi studies can occur because of poorly worded leading questions or selective interpretation of the results. They suggest that this problem can be overcome by using a facilitation team or an unbiased facilitator who has no stake in the results of the study.

Therefore, disadvantages of the Delphi technique include lack of knowledge, respondents not respected, lack of time, facilitator bias, and simplification of issue.

Rationale for selection of the Delphi method. Today the Delphi technique has been used in curriculum development (Finch & Crunkilton, 1989; Rothwell & Kazanzs, 1992). In this study, the technique was conducted to identify essential features in development of a pedagogical model for chemistry teaching through computers.

Due to changes in instruction that have occurred over the last decades as a result of new technology and classroom practices, it was essential to develop a pedagogical model for chemistry teaching through computers in Iranian high schools. The Delphi method, as mentioned earlier, is suited to the needs of the current research problem, that is, identification of the essential features of teaching chemistry through computers. The conceived rationale would be stated as: Firstly, the question to be posed is subjective and calls for value judgment, therefore, the results cannot be analyzed in a statistical manner. Secondly, since high school professionals who are experts in the field of teaching chemistry are widely scattered geographically, this method would allow input from highly qualified individuals without the need for travel and with a minimal commitment of time on the part of these individuals.

Finally, the participants, as high schools professionals, would be very likely to be able to communicate their ideas in writing and, as chemistry teaching practitioners and researchers, would be motivated by their own existing commitment to the topic.

Qualifications of panel members. According to Delbecq et al. (1975), potential respondents should meet four criteria to expect effective participation. They believed that respondents should feel personally involved in the problem of concern to the decision makers, and should have pertinent information to share. Respondents should also be motivated to include the Delphi task in their schedule of competing tasks, and feel that

the aggregation of judgments of a respondent panel will include information which they too value and to which they would not otherwise have access.

The panelists participating in this study were all experienced practitioners and/or researchers of teaching chemistry in high schools. All of these experts are associated with high schools and are now or have recently been involved in chemistry teaching programs. Moreover, many have contributed to the existing literature on chemistry teaching.

However, in order to identify potential participants, the researcher enlisted the assistance of the curriculum department which is comprised of a good team of experts, and the head of the curriculum department who played a significant role in nominating these individuals. The primary list contained forty participants. With the assistance and recommendations from the curriculum department, the researcher selected twenty persons from the list of fellows and requested their participation in the study.

Fortunately, twenty experts responded willingly to participate in the study. This group constituted the final round of the Delphi survey.

Panel size. Helmer and Dalkey used a panel of seven experts in their original Delphi experiment in 1953 (Helmer, 1983). Turoff (1975) suggests a panel size of anywhere from ten to fifty participants.

Wicklein (1993) used a panel of 25 experts in his study. Based on these findings, they continued their experiments using groups of twenty people. For the current research the experts were selected on the basis of their educational level, their rank in the Ministry of Education in Iran, and/or their position in a national University. Either the selected experts had

a Masters Degree or they were Ph.D holders. The panel consisted of 8 university professors (assistant, associate, or full professors) and 12 curriculum directors in the Ministry of Education.

Instrument Design and Implication

Helmer (1983) suggests that it may be necessary to begin a Delphi study with an open-ended question designed to help define and identify potential subject matter to be included in subsequent questionnaires. The first round in the current study (see Appendix G) consisted of a brief survey, designed to collect some demographic data on the participants, and one open-ended question.

The open-ended question was: "In your opinion and based on your experience of teaching chemistry through computer, what are the essential features (contributing factors) of teaching chemistry through computer? Factors here refer to variables such as the teaching and learning methods, the curriculum structure, and technology. Please list 5–10 features which you think should be considered in this regard." The survey was sent out to participants as a Microsoft Word format attachment via electronic mail. The respondents were asked to return the survey by e-mail as well.

For round II a list of 55 features was compiled from the information obtained in the initial survey. However, obviously repetitious statements were eliminated and the statements that were similar but not exactly the

same were maintained. Statements were sorted into two categories: Pedagogical Features, and Technological Features.

Participants were asked to rate each feature on a 5-point Likert-type scale, identifying each feature as a 5 " *strongly agree*"; 4) *agree*; 3) *disagree*; 2) *strongly disagree*; 1) *no opinion / do not know* (noted in Appendix G).

The third and the final round questionnaire listed only the features that had received a mean rating of 4.0 or higher in the previous round. In order to confirm the steps taken, once again the statements were placed into the two areas of Pedagogical and Technological factors.

The mean score for each statement was indicated on the questionnaire by an "x" placed on the scale in the appropriate place. At the end of this questionnaire, participants were asked to answer the following open-ended question:

"The curriculum department of the Ministry of Education in teaching chemistry through computer has introduced changes for the last decades. In your opinion, will these changes continue over the next decade? Why or why not?" (noted in Appendix G).

Data Analysis of Experts' Consensus

Responses to questionnaires 2 and 3 were analyzed to determine the group rankings of the statements. Mean score, mode, standard deviation, and range were computed for each of the statements. Furthermore, the levels of agreements were determined for each statement by calculating the

percentage of panelists who rated statements as "strongly agree" or “agree". Responses to the open-ended question on the final questionnaire were analyzed qualitatively.

Summary of Data Collection and Analysis Procedures

This section summarizes the data collection and data analysis procedures for the responses obtained from the experts in this study. Table 3.7 outlines the three-round Delphi procedure that was followed in this study.

Table 3.7

Summary of Delphi Process

	Round 1	Round 2	Round 3
Date mailed out: Date due back	20/Aug/2008 10/Sep/2008	15/Sep/2008 20/Sep/2008	1/Oct/2008 5/Oct/2008
Instrument	Open-ended survey	Questionnaire 1	Questionnaire 2
Data collected	Demographic information and list of 5-10 essential features of teaching chemistry trough computer in high school.	Level of agreement (on a five point scale) for each identified feature.	Level of agreement of the remaining features by mean, mode, standard deviation, range, percentage, and response to open-ended inquiry.
Data Analysis	Compiled list of features Prepare Questionnaire 1 using the compiled list.	Compute mean, mode, standard deviation, range, and level of agreement for each statement. Prepare Questionnaire 2 using only statements receiving highest ratings and including mean	Analyze changes in agreement for each statement. Draw conclusions based on results.

Throughout the study (Phases 1, 2, and 3), the researcher served as the designer of the learning environment with use of computer, team work with teachers and students, where T-retest method was used for the development of the pedagogical model in teaching chemistry. Before the T-retest phase the two ICT experts and the chemistry curriculum developers were asked to study the questionnaire and comment on questions' fitness with the formulated research objectives.

The questionnaire was approved by the experts. Upon approval of the experts and assurance of its validity, the questionnaire was tested across a sample of 30 students randomly obtained (Patton, 1990). Some measures of descriptive statistics and inductive statistics were used for data analysis. The statistical indices and the employed tests consisted of mean, standard division, *z*-score, and Wilcoxson test. During this phase the researcher developed a recorded tape of teaching chemistry through computer-assisted guided inquiry that was the prime objective of this project. The researcher used a range of software applications to integrate texts, digital video clips and freeware in order to develop the tape content. Eventually, the researcher made the film available in DVD format. The intention of this development was to distribute these findings among other prospective researchers as well as interested practitioners for future reference. The content of the tape is believed to have provided information on initiatives for implementing ICT into current practice of teaching the chemistry subject to Iranian high school students.

Validity and Reliability

Patton (2002) advocates the use of triangulation where he states: "triangulation strengthens a study by combining methods". This can involve use of several kinds of methods or data, including both quantitative and qualitative approaches. As described before, this research was both quantitative and qualitative (mixed method). However, it is assumed that the extended length of the data collection and the use of participant's actual language in the natural setting strengthen the Internal Validity.

The researcher assumes that, in this particular research, in order to boost the validity measures, the reliability of the research design, the findings and the calculated measures could be promoted through triangulation that comes from multiple data sources.

These multiple data sources includes both observation and interview to understand the features (attributes) of the teachers' roles, the students' roles, the interaction between them, the technology roles, and the in-classroom practice, b) The extent of the rigidity of data that results from phase I to achieve the phase III inventory instrument, and c) The development as a whole which is the outcome of the combined methods and the scope of the project.

On the other hand, the reliability criteria also included understanding of the role changes in the learning environment and its development across the teaching and learning process. Furthermore, this research is supposed to have provided useful knowledge about chemistry teachers and high school students using computers. It could also be useful for the purposes of developing a pedagogical model for chemistry through computer-assisted guided inquiry.

Research is also valid if it achieves credibility, dependability, transferability, and conformability (Guba & Lincoln, 1985). These measures, to the best knowledge of the researcher, are considered cumulative in a sense where they are claimed upon achieving multiple measures from different sources. Adding to these measures, the researcher is familiar with issues of teaching at high school, learning controversies, researching issues related to education, and has 10 years of experience in

producing educational Chemistry films based on textbooks. However, she has been known for 10 years as an expert and teacher in this field which is supposed to have added to the credibility of the findings.

The participating teachers, students, principals, ICT teams, and experts involved in this study also contributed to its credibility. A detailed record of the two phases of this research procedure and their results is completed that is boosting the transferability measure. Moreover, the readers could also follow the test of this research and evaluate its validity and reliability in order to confirm conformability and leave an audit trail.

This research design (methods, analyses processes, and results) had also been confirmed by the supervisor, and the advisor which promotes the dependability indices. Teachers, students, principal, ICT team, and experts who participated in this research also supported the findings. Valuable feedback and advice also would be obtained from published papers.

Ethics of Research

Throughout the process, researcher has attempted to maintain good ethical practice by assuring respondents that the researcher would treat all data in confidence, and assure that all references would be made anonymously and be unattributable to individuals.

The researcher and participants agreed to give a copy of this project report to the teacher's school as it is assumed to be useful for future reference. Permission was also sought via the principal of each school and the purpose of the research was negotiated. The researcher has submitted a

list of the semi-structured observation and interview questions to the principals prior to administration in order to obtain the instrument's unobtrusiveness characteristics.

Summary of Research Methods

As mentioned in Chapter One, this study is designed to develop a pedagogical model for teaching Chemistry with the use of computer-assisted guided inquiry at Iranian high schools. Research methodology included both qualitative and quantitative methods. A comprehensive account of the techniques and procedures used in this research is presented in Table 3.8.

Table 3.8

A Summary of the Methodology Used of this Study

Research Question	Research Studies	Methods Employed	Number of the Participants
1. What is the status of the computer-aided teaching of chemistry subject in the 11th grade of the Iranian High schools?	Phase 1 Study concerning teaching with the use of computer at high school	Video recordings Observations Interviews Group interviews	Teacher=each school 1 total=10 Student=each school 3 total=30
2. What are the contributing factors to the success of computer-based activities in classroom in teaching chemistry to the 11th grade students in the Iranian high schools?	Phase 2 Study concerning principals' and ICT teams' views about computers	Interviews	Principal=each school 1 total=10 ICTTeam=each school 1 total=10
3. What are the essential features for the development of a model of teaching chemistry subject with the aid of computer to the Iranian high school students in grade 11?	Phase 3 Study concerning experts' views about infrastructure, and pedagogical features	Delphi technique Interviews	Experts total=20