CHAPTER V

SUMMARY, RECOMMENDATIONS, AND CONCLUSION

The purpose of this study was the development of a pedagogical model for teaching chemistry through computer-assisted guided inquiry at Iranian high schools. This study used a combination of qualitative and quantitative methods that are related to current pedagogical practice in the classroom. Other supporting data included audio tape transcripts of ten chemistry classrooms/lessons and interviews with principal and ICT teams, Delphi technique, and surveys of students' perspectives concerning the computer-based activities used in their chemistry classes. This chapter summarizes the results of this study, discusses some implications of these findings, and offers some useful suggestions for further research.

Summary of Results

This study indicated a wide range of factors affect the pedagogical model of chemistry classes through computer-assisted inquiries in the 11th grade of the Iranian educational system. These issues have been categorized into three domains: 1) teachers' focus on personal and professional issues on integrating technology requires more time and energy to confirm computer is known as a facilitator for teaching and learning rather than a replacement or obstacle, 2) pedagogically speaking, the focus must be on the student as the center and the teacher as the facilitator who helps students to negotiate and control their time, curriculum, and computer activities within the

curriculum in the classroom, and provides materials, 3) the principal issues must be attentively recognized as they are concerned about teacher professional development, budget, and infrastructure, 4) the ICT team focused on hardware and software, and they appeared supportive of teachers in the classrooms, 5) the experts were found to have focused on environmental and pedagogical features, and 6) students were focused on students' perspectives and on performance of the computer-related activities in the classroom.

The Design Development Pedagogical Model for Chemistry 11

Looking at the research project, it is clear that the need for teaching chemistry, according to the theoretical framework and the conceptual framework (Robitaille, 1996), is focused on current situation finding problems, and future development. Particularly, the presence of computer is essential in class activities, as emphasized by the Curriculum Council, Ministry of Education (1998).

However, little has been seen of ICT use in chemistry classrooms by teachers in high schools. Hence, there is the need to create classrooms that encourage teachers and students to implement computers in chemistry teaching and learning. In order to implement ICT there are essential concepts to understand, to teach, and to think critically through inquiry. Nevertheless, a few research-based studies had focused on this topic.

Furthermore, there is the need to support students' critical thinking in chemistry at high schools to increase their understanding of chemistry learning as far the difficulty of the subject matter is concerned. In addition,

there is the need to obtain new ways (e.g., pedagogical model) to apply directly in chemistry classrooms in order to support learning of chemistry. In particular, there is a need to carry out an investigation, especially in the context of conceptual chemistry at the high school level because most of the students have misconceptions of these issues. Support for the use of computers in the chemistry classroom is also needed, as was clearly observed throughout the research. Eventually, a pedagogical model related to the purpose of this study including three phases (see Chapter 3) based on the needs described and the previous researches available was developed. The new model of the guided inquiry in chemistry contains: a) teamwork, b) mind tools, c) collaborative activities, d) learning cycle, including learning diary in a small group, and reporting. All phases were designed to be parts of the chemistry curriculum for one lesson (around 2 hours), and thus can be applied to classroom practice. The pedagogical model based on guided inquiry (Igelsrud & Leonard, 1988), and the prototype studies (see Chapter 4), could create positive atmosphere for chemistry teaching.

Developmental Process of Pedagogical Model at High School

As described in Chapter 3, the aim of this research design methodology was to understand not only design and the development of a pedagogical model but the design process itself. As an outcome of this research design, three stages were recognized in developing a pedagogical model (see other models described in Chapter 2). The characteristics of a good research design as described by Robitaille (1996), guided the current research process (see Chapter 3).The needs of participants and the

policymakers (e.g., national curriculum framework in chemistry) were taken into account during this design.

However, in this design process, based on the theoretical and the conceptual framework described in Chapter 2, some special features related to the goals were highlighted in this design process. Therefore, it is assumed that the learning described in the model is authentic, active, constructive, reflective, and cooperative. The mixed triangulated methods of qualitative and quantitative research in this particular case were intended to better understand the use of technology in education. Videotapes, natural observations, group interviews, Delphi technique over three phases, and surveys with various methods were used in this research. Ten chemistry teachers from ten schools, 30 students from ten schools, 10 principals from ten schools, 10 ICT teams from ten schools, and 20 experts from the Ministry of Higher Education and the Ministry of Education had participated in this study. The design of this research emphasized the participatory role of practice in the classroom (Robitaille, 1996). This research proved successful in obtaining the ideal procedure to find and solve problems in using the computer in chemistry classrooms.

Knowledge Domain of Chemistry: Teaching and Learning through Computer-Assisted Inquiry

As described in Chapter 2, meaningful learning is a way that helps students to use their knowledge practically. Successful learning in classrooms was found to depend on three factors: 1) meaningful learning, 2)

the prior knowledge of students (e.g., concepts), and 3) inherent meaningfulness of the new concept (Ausubel, Novak, & Hanesian, 1978). Learning depends on the role of teachers, students, their interactions, and technology available (Robitaille, 1996).

Moreover, the pedagogical practice in the classroom depends on the contexts outside of the classrooms (Kozma, 1999). This research design showed that the role of ICT in pedagogical practice in classrooms, and the critical thinking used by students could be utilized to build useful phenomena for the outside of the learning context. However, the Guided inquiry supported the students' learning through practice. It was realized that the students engaged in an active social discourse related to a chemistry phenomenon posed questions and learned the critical thinking skills for analyzing their experiences. Moreover, this study showed the role of technology in using pre-knowledge of the students and leading them to complete their inadequate learning. The computer motivated the learners to learn chemical phenomena.

Igelsrud and Leonard (1988) highlighted the role of the teacher in determining an appropriate level of inquiry. In guided inquiry teacher poses a question (e.g., what) and tries to use the students' prior knowledge (Ausubel et al., 1978). Similarly, critical thinking (Narode et al., 1987) has been assumed as a learning goal (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). In this model the student is at the center (Vygotsky, 1978), and the teacher is the negotiator and facilitator. In particular, the explanation phase included teamwork, collaboration, mind tools, and engaged students with using critical thinking related to the phenomena. The

reporting was considered as an opportunity for students to reflect their thoughts and summarize their investigation. This result also supported a view of using the computer to enhance the quality of teaching and learning process (Cox et al., 2003; Papert, 1980; Voogt & Pelgrum, 2005; Watson, 2001).

The guided inquiry model was central in this study. It engaged chemistry 11th grade high school students in active interaction with each other (see Chapter 4), and supported each other in their chemistry thinking and actions (Aksela, 2005). Some cognitive developments (Germann, 1989) resulted from students' social interactions, but during this process, the overall interaction was poor. Different elements had important roles in this study such as the role of the schools in supporting their teachers (Fullan, 1993), and the role of technology. The teachers needed to gain knowledge and skills that could be used in their teaching learning process.

Moreover, it was realized that they should cooperate with their coordinators. The teacher should be prepared and be able to adapt to the assigned role changes. However, these factors supported the goals of this study, particularly through experts' consensus.

Implications of Research Findings

This study showed that computer use entails application of many different internal and external factors (Fullan, 1998). As one of these factors, the principals needed to clearly illustrate the role of technology and the subordinate teachers needed to know how to integrate these technologies into their classrooms. Teachers should share their technical and practical

methods together. Similarly, schools have to prepare special facilities for teachers and students, and then try to solve their software and hardware problems as soon as they could.

It was also found that the presence of an ICT team was essential at schools, and they should have enough knowledge of computers and be able to provide suitable places for teachers and students to work on these facilities. Without this support, the teacher could not be successful in teaching. As mentioned in Chapter 2, the teacher's beliefs, ideas, and attitudes would strongly influence her practice (Alexander, 1992). More or less, the chemistry teacher can also influence students and their motivations. Another finding of this research, based on the experts' point of view and the results of the interviews and observations conducted, the use of ICT in teaching chemistry should be integrated into the curriculum (Curriculum Council, 1998). This was realized to be a commonly emphasized theme across the globe.

From another angle, the role of teachers in this study was found to be very important. They transferred the materials to the students and worked cooperatively toward reaching common goals. It was realized that these knowledge dealers need to receive more training to ensure their roles are performed well. Any training program needs to ensure that chemistry teachers are aware of the benefits of using computers (British Educational Communications and Technology Agency, 2004). It must be emphasized, however, that prior to any training teachers need to believe in the potentials of including ICT in their classroom practice.

Moreover, the teachers should know how to implement a curriculum that addresses their goals, and how to plan lessons that are rich in such goals (Kennewell et al., 2003). This research provided an example of guided inquiry in the 11th grade level of chemistry classes at high school for using computers in classroom practice. The students used the computer as a tool for learning and teachers used it for teaching.

Recommendations for Future Research

This study showed that teachers attempted to change their normal practice by using computers in the students' learning environment. The findings of this study suggested further research studies and questions such as: "What is the curriculum pattern?", or "What are the roles of teacher, student, and computer in the classroom?", and "What are the impacts of these patterns on student outcomes?", or even, "How do we plan and establish policy as a suitable supportive system for using computers in classroom?".

Moreover, it could be asked, "Which model is more useful in the classroom?" This study can also be extended to other subjects by using proper facilities, teachers, students, and knowledge.

Conclusions

The main goal of the study was the use of computers in the 11th grade level of high school. As presented in Chapter One, the implementation of computers is new and the findings of this study show that practice (i.e.,

the teachers who attempted to change their practice with new pedagogy) requires a great deal of support, time, planning, and implementation contemplations.

In particular, a teacher who is attempting to practice the implementation of ICT (computer) deals with the duality of the implementation of the new pedagogical practice as well as the computer. Software and hardware have an important place in the practice and pedagogy, but many issues influence their implementation and use. Teachers need special training and support to incorporate computers into the classroom. School leadership and the Ministry of Education should support them. Software and hardware need to be provided and developed; the teachers should be trained in using computers in the chemistry classroom.

The findings of this study suggest that the chemistry curriculum needs some changes based on ICT, pedagogical model, and Internet that helps teachers prepare themselves. This study has attempted to investigate the pedagogical practice in the classroom and factors that influence practice through the development of a pedagogical model for chemistry through computer-assisted guided inquiry.

This study shows that there are many issues influencing pedagogical practice in classrooms and the key was to try and use computers as a tool for teaching in the classroom for different subjects. The use of computers in teaching chemistry made students think critically through the combination of technology with classroom activities. Students not only learned some new materials in their lessons, but they also understood some abstract materials better by using the computer.