Chapter 6

Conclusion and recommendations

This chapter serves as a conclusion for the entire study. In this chapter a brief overview of the study will be given, the results obtained highlighted and finally recommendations for future studies will be given.

6.1 Conclusions

One of the main goals of the research in this field of study was to develop an artificial pancreas. This closed loop control system will consist of a control algorithm, insulin pump and a continuous blood glucose monitor. The control algorithm for the artificial pancreas has been a focus point of research in this field since the 1980's.

As the technology improved, the amount of research has increased in the field of modelling the BG subsystem by using mathematical models. Several models exist that differ in complexity. The minimal model of Bergman was one of the first to be recognised worldwide, and is the least complex model to date. Several researchers have used this model as starting point for the derivation of their own model.

Several models currently exist with the main purpose of educating people with diabetes, however none with an integrated approach to incorporate all the external - and internal influences on the BGL. This led to the development of the *Edutool* diabetes simulator. It uses the ets concept to determine the energy value of food, beverages, alcohol, stress, exercise and the RH and CRH.

The ets concept was derived from first principles and is person specific. It takes into account the metabolic efficiency of the CHO and the rate of CHO metabolism for the specific person being modelled. The mathematical model of the human blood glucose subsystem could now be modelled in an accurate and much less complex manner.

The *Edutool* diabetes simulator is an integrated simulation model that incorporates the ets concept to accurately simulate the BG response of a specific person with type 1 diabetes. The experimental validation of the model is essential, although it is commonly accepted that these educational models are beneficial and necessary.

The comparison and evaluation between *Edutool* and AIDA was questionnaire-based. Two different age groups (i.e. 13 years and 17 years old, respectively) each assessed the *Edutool* according to a trial protocol developed. If these non-diabetic people at this early age could understand the concepts of the *Edutool* and complete the questionnaire, then it would be very easy for adults and diabetes patients to understand.

Questionnaire 1 received an average total test score of 62.90% with a standard deviation of 18.09%. After viewing the presentation and working on the *Edutool* the average total test

score increased to 88.24% with a standard deviation of 11.89% ($p < 0.001$). This results in a 0.4-fold improvement (40% increase) in the results of the knowledge based questions.

The participants all preferred the *Edutool* when given the choice between the *Edutool* and AIDA. This indicates the user-friendliness of the *Edutool* in comparison to the AIDA simulator, as assessed by this group.

The secondary school trial took place at Curro College Hazeldean, in Pretoria. The grade 11 class was made available for participation in the trial. Questionnaire 1 received an average total test score of 64.42% with a standard deviation of 13.14%. Questionnaire 2 received a 87.02% mean score with a 9.62% standard deviation ($p < 0.001$). This results in a 0.35-fold improvement (35% increase) in the diabetes and BG knowledge of the participants after watching the presentation and working on the *Edutool.*

The secondary school participants also all preferred the *Edutool* in comparison to the AIDA simulator. *Edutool* is available in Microsoft Windows which is easier to understand and navigate in. This must have greatly influenced the user-friendliness of the *Edutool*.

It was expected that the fold improvement of the secondary school trial would be less than the same for the primary school trial. This is due to the higher level of baseline knowledge the secondary school learners will have because of their age, and that they might have had biology as subject.

Both trials resulted in success, due to the significant increase in overall test results. It can be deduced that the *Edutool* has met its target of educating the participants in the basics of diabetes and BG. The *Edutool* was experimentally validated by non-diabetic people and the user-friendliness of the program assessed. The results indicated that the *Edutool* diabetes simulator is a successful educational simulation model based on the results from these trials.

6.2 Recommendations

Several recommendations can be made for future studies. They will now be listed below:

1. The trial must be expanded to include people with type 1 diabetes. It was not possible to include such a group in this trial due to the lack of time. Mr Michael Brown of the CDE in Johannesburg has indicated that several of his patients were willing to participate.

2. A larger sample group should be used in the future trials to increase the statistical power of the trial.

3. The quick start presentation should be expanded to include explanations of how the *Edutool* simulates exercise, alcohol consumption, stress and calculation of an insulin regime. This was included in the presentation for this trial, but excluded due to the complexity level of these features for school children to understand.

4. To increase the number of participants in the trial, it would be beneficial to load the trial protocol and questionnaire 1 and 2 onto the diabetic *Edutool* web site. Each person that downloads the *Edutool* must be asked to participate in the trial. However, the problem with this type of response might be that people will not follow the protocol precisely. This could lead to errors in the results.

5. Repeat the same trial after a specific period of time with the same group of participants. This is done to test the reliability of the questionnaire in a test-retest manner.