UNIVERSITEIT TWENTE.

Bachelor Thesis

[201000166]

Teaching quantum mechanics using qCraft

Author:
Micha van den Enk
[s1004654]

Supervisors:
Dr. H. H. Leemkuil
Second supervisor

April 28, 2015

Contents

Preface

The Generic Model

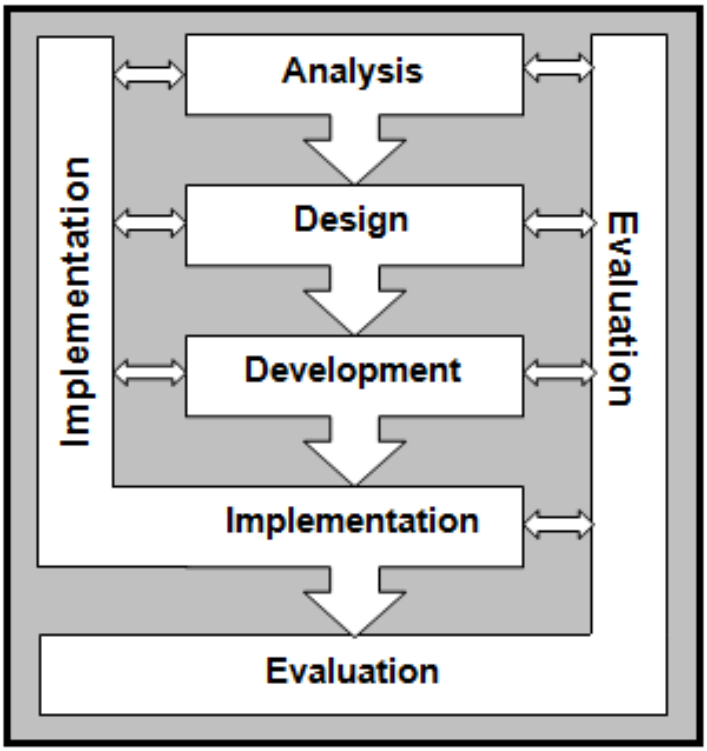

Figure 1: The generic model by Plomp et al. (1992)

Analyses

The first step of the Generic Model by Plomp et al. (1992) (see figure 1 on page 4) is Analysis. Smith and Ragan (2005) give an elaborated description of how to perform these analyses for instructional design. They distinguish three different kinds of analysis: analyzing the learner context, analyzing the learner and analyzing the learning task. The analysis of the learning context can provide the instructional needs and a description of the different factors influencing the instruction. The purpose of the learner analysis is the characterization of the end user of the instruction, which is in this case the middle school students. In the task analysis the test specifications are written, with which the content of the instruction can be established.These three analyses are executed in the following three chapters.

Context Analysis

A learning task always takes place in a certain learning context. In this case this is the middle school. It entails not only the place, but also the temporal and social environment (Smith & Ragan, 2005). The analysis of the learning context can provide the instructional needs and a description of the different factors influencing the instruction. With the instructional needs, the designer can establish the main learning goals for the instruction. The description of the learning environment can provide the learning opportunities and constraints which have to be taken into account for the instruction.

Needs Assessment

The first goal of the need assessment is to investigate whether there exists a need for the instruction. Without a need, it would be a waste of resources to develop the instruction (Smith & Ragan, 2005). Next to this, it is conducted to better specify the need for the instruction. In the context of instruction, the assessment often results in a learning goal, which is the main goal of the instruction. This main goal is needed to continue the rest of the analyses, because all other analyses are conducted in respect to this goal. The goal can also be used to construct the summative evaluation, because when this goal is achieved, the instruction has proved to be successful.

The condition

Smith and Ragan (2005) identify three different models for the needs assessment, namely the problem model, the innovation model and the discrepancy model (see figure 2). The problem model is used when there exists a problem in the current system which has to be solved. As can be seen in figure 2, this model can be used as a prerequisite for the other two assessments. With this model, it is determined whether there really is a problem, whether the cause of the problem is related to emloyees' performance or learners' achievement, whether the solution to the problem is learning and whether instruction for these learning goals is currently

offered. After the problem model, the needs assessment splits into the two other models. The innovation model is used when there is a new learning goal that the learners should achieve, and the discrepancy model is used when the already available instruction is not adequate to achieve the learning goal. The designer should choose one of these models for his needs assessment.

Figure 2: The three sides of needs assessment (Smith & Ragan, 2005)

The problem

Cause of the problem

Is the solution learning

Instruction currently offered

Nature of the innovation

Learning goals

Priority and suitability

Learning Environment

Teachers

Existing curricula

Equipment

Facilities

Organization

Larger system

Learner Analysis

The second analysis is that of the learners (Smith & Ragan, 2005). The purpose of this analysis is the characterization of the end user of the instruction, which is in this case the middle school students. For this analysis it is important to determine the similarities and differences between the learners. Smith and Ragan (2005) provide a list of factors which play a role in designing the instruction. They catagorize these factors with a 2×2 matrix (see table 1), creating the catagories stable similarities, changing similarities, stable differences, and changing differences.

	Similarities	**Differences**
Stable	Stable similarities	Stable differences
Changing	Changing similarities	Changing differences

Table 1: The four catagories of Learner Characteristics (Smith & Ragan, 2005)

Stable Similarities

Sensory capacities

Information processing

Types and conditions of learning

Changing Similarities

Intellectual development processes

Language development processes

Psychosocial development processes

Moral development processes

Other development processes

Stable Differences

Aptitudes

Cognitive styles

Psychosocial traits

Gender, ethnicity, & racial group

Changing Differences

Intellectual development state

Other development state

General prior learning

Specific prior learning

Task Analysis

The final step is analyzing the learning task (Smith & Ragan, 2005). In this analysis the goals from the needs assessment during the analysis of the learning context have to be translated to test specifications, with which the content of the instruction can be established. In order to achieve these test specifications, first the type of learning has to be established. Having this established, the information-processing analysis can be conducted. Every type of learning has its own kind of information-processing analysis. Zeilinger (2005) provides a clear conceptual understanding of quantum teleportation, and will therefore be used to conduct this information-processing analysis. The next step is the prerequisite analysis. The outcome of this has to correspond to the outcome of the learner analysis. Finally, the learning objectives can be written, which form the test specifications. Every learning objective has to contain a description of the terminal behaviour or actions that will demonstrate learning, a description of the conditions of demonstration of that action and a description of the standard or criterion (Smith & Ragan, 2005). Every learning objective will fall into a category of Bloom his taxonomy of learning objectives (Bloom, Englehart, Furst, Hill, & Hrathwohl, 1956), and will use appropriate action verbs. Most learning objectives within will be knowledge objectives, because there is a lot of new knowledge which has to be provided and it forms the basis for all other objectives. There will be no or very few synthesis and evaluation objectives, because these objectives would take too much time within the instruction to achieve to be feasible to use.

Learning goal

Types of learning

Information-processing analysis

Prerequisite analysis

Learning objectives

Test specifications

Theoretic Framework

Design

Development

Formative Evaluation

References

Bloom, B. S., Englehart, M. D., Furst, E. J., Hill, W. H., & Hrathwohl, D. R. (1956). *Taxonomy of educational objectives: Handbook i, cognitive domain*. New York: McKay.

Plomp, T., Feteris, A., & Pieters, J. (1992). *Ontwerpen van onderwijs en trainingen* (W. Toic, Ed.). Utrecht: LEMMA.

Smith, P. L., & Ragan, T. J. (2005). *Instructional design*. Oklahoma: John Wiley & Sons, Inc.

Zeilinger, A. (2005). *Einsteins spuk. teleportation und weitere mysterien der quantenphysik*. München: C. Bertelsman Verlag.