Remember fast, act skillfully

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2010

document version
Publisher's PDF, also known as Version of record

citation for published version (APA)
de Vries, W. (2010). *Remember fast, act skillfully: Training methods for Basic Life Support; analysis from an educational perspective*. [PhD-Thesis – Research external, graduation internal, Vrije Universiteit Amsterdam].

2 Conceptual framework of the thesis

Basic educational elements

Three educational elements have to be taken into consideration when studying education in cardiopulmonary resuscitation (CPR) and the use of automated external defibrillators (AEDs). These elements are:

- Adult education;
- Educational evolution;
- Retention and retrieval of learning results.

These elements are relevant to understanding practical CPR and AED training, and they also provide the basic structure of this thesis. The aim of the studies in this thesis is to collect evidence on whether alternative learning methods improve retention and accelerate retrieval.

Adult education

Defining adult education in a uniform way is difficult, if not impossible. Table 1 gives an overview of the most current definitions for adult education. Based on these definitions, this thesis focuses on the following aspects:

1. Adult education focuses directly on acquisition in the daily life of the learner instead of focussing on the future;[1-4]
2. Adults have life experience and can construct new knowledge based on this experience (scaffolding);[5,6]
3. Adults are fully responsible citizens in society and have interrelated responsibilities. They therefore are also responsible for their own learning process.[7]

Voluntary participation by the learners is a common aspect of adult education, motivated by the professional or personal need for development. During adult education, learners have the opportunity to provide input from their own personal experiences during the learning process.

Scientist	Definition
Lindeman[1]	Education is life--not a mere preparation for an unknown kind of future living. The whole of life is learning; therefore, education can have no ending. This new venture is called adult education--not because it is confined to adults but because adulthood, maturity defines its limits.
Bryson[8]	Adult Education is all the activities with an educational purpose that are carried on by people, engaged in the ordinary business of life.
Verner[2]	Adult Education is the action of an external educational agent in purposefully ordering behavior into planned systematic experiences that can result in learning for those for whom such an activity is supplemental to their primary role in society, and which involves some continuity in an exchange relationship between the agent and the learner so that the educational process is under constant supervision and direction.
Knowles[9]	In its broadest sense, Adult Education describes a process--the process of adults learning. In its more technical meaning, Adult Education describes a set of organized activities carried on by a wide variety of institutions for the accomplishment of specific educational objectives. In the sense of a movement or field of social practice, Adult Education brings together into a discrete social system all the individuals, institutions, and associations concerned with the education of adults and perceives them as working toward common goals of improving the methods and materials of adult learning, extending the opportunities for adults to learn, and advancing the general level of our culture.
Courtney[3]	Adult Education is an intervention into the ordinary business of life--an intervention whose immediate goal is change, in knowledge or in competence. An adult educator is one, essentially, who is skilled at making such interventions.
Houle[4]	Adult education is the process by which men and women (alone, in groups, or in institutional settings) seek to improve themselves or their society by increasing their skill, knowledge, or sensitiveness; or it is any process by which individuals, groups, or institutions try to help men and women improve in these ways. The fundamental system of practice of the field, if it has one, must be discerned by probing beneath many different surface realities to identify a basic unity of process.
Merriam & Brockett[10]	Adult education is the activities intentionally designed for the purpose of bringing about learning among those whose age, social roles, or self-perception define them as adults.

*Table 1. **Current definitions of Adult Education.***

Educational evolution

Transfer Model

Education traditionally took place in the classroom until the 1970s. The learners were the passive absorbers of knowledge that was transferred from teacher to learner. Learners were only occasionally provoked to react to the information provided or to interact with each other. Education according to the transfer model uses media that allow a teacher to deliver information to the learners, such as manuals, hand-outs, video and PowerPoint presentations.[11] (Table 2) The learning objectives are set by the teacher or learning institution, sometimes based on national guidelines from government or government-financed public bodies. Learning objectives are concrete and the same for all learners.

Independent learning model

In the 1970s, educators became aware that education becomes more successful when learners take a more active role in their own learning process. The role of the teacher is to help the learners find the correct information, to give tips and tricks, and to facilitate the learning process. (Table 2) In this model of independent learning, learners construct their own knowledge, but are still focussed on a pre-defined learning result. They use facilitating tools such as workbooks and memory cards. Initially, audiovisual aids gave teachers the opportunity to help learners construct new knowledge. More recently the computer, CD-ROM, DVD and the internet were introduced to respond to questions and to collect information.

Interactive learning model

During the mid-1990s educators endeavoured to satisfy individuals' learning preferences. The facilitating tools were no longer a decision of the teacher, but chosen by learners themselves. The increasing availability of media led to the evolution from independent learning to interactive learning. Learners described their learning objectives based on their personal needs. They did so with the aid of interactive media to gather new information, and contact with specialists for consultation or feedback to elaborate theoretical knowledge or skill acquisition. Personal computers with and without internet connection, active boards, podcasts, and Mp3 and Mp4 players became available as educational aids.

Search engines such as Google and others, provide opportunities to gather information quickly and efficiently. New technologies allow the use of on-line training programs and connect other learners or experts in informal and formal networks ("communities of learners"), such as Facebook and MySpace, but also in formal, closed communities. (Table 2)

Transfer model	Independent learning Model	Interactive learning Model
Teacher-centred.	Learner centred, individual learning.	'community of learners'- centred.
Learner passive.	Learner active.	Learners construct the education.
Technology: manuals, video/TV.	Technology: workbook, computer as information source.	Technology: workbook, computer as communication tool in the network and as task environment.

Table 2.
Three didactical concepts.[11]

Transfer, retention and retrieval

Before skills and knowledge become available for immediate use, they must be stored in long-term memory. This process of constructing new knowledge from new information combined with personal experience and former knowledge is called transfer.[12] The term 'transfer' should not be confused with the term as used in 'transfer model'. In the latter, transfer refers to the way information passes from instructor to learner.

Retention is the process of storing and consolidating new information in the long-term memory of the learner. Unfortunately the size of the body of retained information and the relative decrease or increase of retained information cannot be measured. Retrieval is therefore an important concept, because it can be measured and quantified.[13,14] In a classical study in which nonsense syllables had to be recalled, the curve looked more or less like a power-law curve: after an immediate and steep decrease, recall remains at a more stable level for an extended period.[15,16] (Figure 1) Retrieval is the process of finding and awakening knowledge which is stored in long-term memory and brought to the working memory so that the learner is aware of the knowledge, which can now be used.[17]
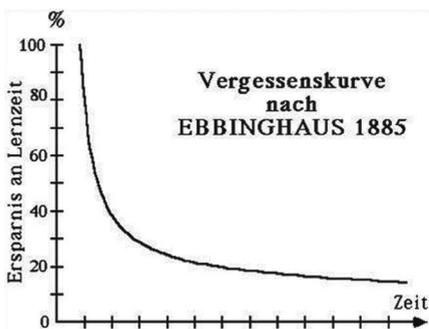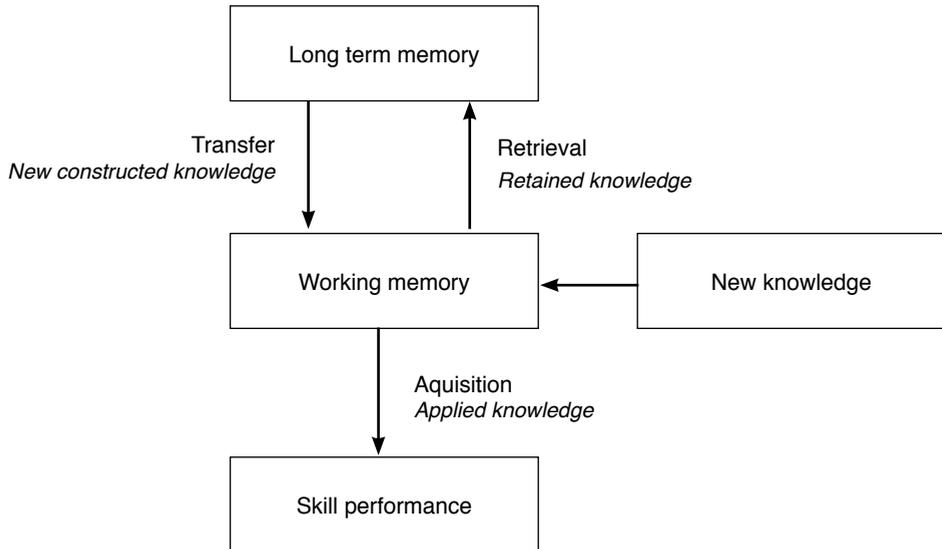
Figure 1.
The Ebbinghaus Forgetting Curve.[15]
(Free of rights since 1979)

It is not only important that new knowledge is stored in memory, but also that the information is remembered at the appropriate moment. (Figure 2)
In studies on retention, the retrieved information is seen as an indicator of the retained information.

Figure 2.
Relation between transfer, retention and retrieval.

Education elements in cardiopulmonary resuscitation and the use of automated external defibrillators
As mentioned previously, the elements of education are relevant to understanding practical CPR and AED training. Each element will therefore be explored.

Actual situation
The European Resuscitation Council (ERC) recommends that CPR and AED courses be given in 3-4 hours, with one instructor per six students at most.[18] The ERC has made a standardized PowerPoint presentation and a manual available for instructor use.[19] Each National Resuscitation Council can translate these media into their own language(s).
Instructors work through the curriculum in parts (CPR, the use of an AED and the recovery position), in a way that is comparable with mastery learning. Mastery learning implies that the course content is divided into

manageable units, with learners studying and taking tests until they have the appropriate level of mastery.[20-22] Each unit within the ERC CPR/AED course starts with a short lecture where instructors use the relevant part of the standard ERC PowerPoint presentation. They then give a demonstration and provide skills practice, using a four stage approach to improve retention. Stage 1 is a demonstration of the skill, performed at real speed, without explanation. Stage 2 is a repeat demonstration with dialogue informing learners of the rationale for the specific actions. Stage 3 is a repeat demonstration guided by one of the learners. And stage 4 is practice of the skill by all learners.[23,24]
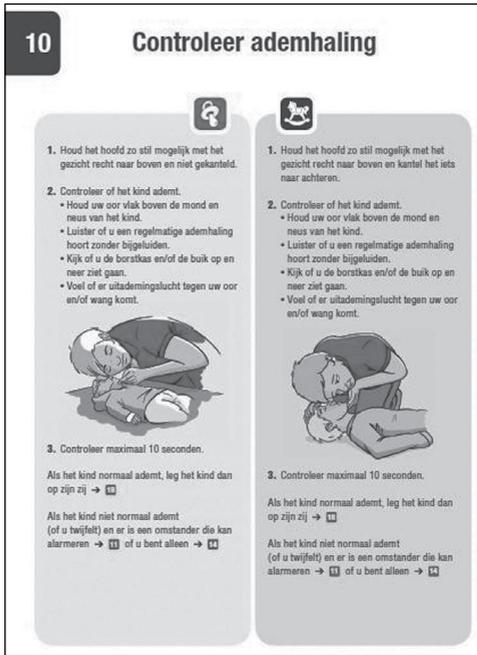
Adult Education
Most learners of CPR and AED use are adults. The instructional material and organization of the course are generally in accordance with the principles of adult education, even when young learners are being trained.[25-28] Learners are responsible for their own learning process with regard to resuscitation skills. The learning objectives are mostly set by the European or National Resuscitation Council, and sometimes by other agencies or institutions. Learners follow a CPR and AED training course voluntarily or as a requirement for their profession.

Didactical models
Current CPR and AED training is instructor-based, which mirrors the transfer model. Learners are active when it comes to practising skills, but they are passive in the way they construct their knowledge. The instructor has a uniform way of delivering the training course (lecture and four-steps approach), and uses one-way media such as a manual, PowerPoint presentation, and demonstration.
Training materials for CPR and AED use have only recently been developed with the independent learning model in mind. For instance, the ERC CPR and AED manual uses tabs at the bottom of the pages; decision trees make it possible to navigate the manual through different paths instead of following a linear (and thus uniform) approach from the first page to the second, and so on until the final page.[29]
The interactive learning model has been introduced into resuscitation education. The Dutch Paediatric Basic Life Support (PBLS) manual is an example.[30] It is (nearly) impossible to use the PBLS manual to learn in a linear way. (Figure 3) Students have to make frequent decisions and based on these decisions, they navigate to other pages. As far as we know, there are not yet independent communities of learners linked to CPR and AED.

10 **Controleer ademhaling**

1. Houd het hoofd zo stil mogelijk met het gezicht recht naar boven en niet gekanteld.

2. Controleer of het kind ademt.
   • Houd uw oor vlak boven de mond en neus van het kind.
   • Luister of u een regelmatige ademhaling hoort zonder bijgeluiden.
   • Kijk of u de borstkas en/of de buik op en neer ziet gaan.
   • Voel of er uitademingslucht tegen uw oor en/of wang komt.

3. Controleer maximaal 10 seconden.

Als het kind normaal ademt, leg het kind dan op zijn zij →

Als het kind niet normaal ademt (of u twijfelt) en er is een omstander die kan alarmeren → of u bent alleen →

1. Houd het hoofd zo stil mogelijk met het gezicht recht naar boven en kantel het iets naar achteren.

2. Controleer of het kind ademt.
   • Houd uw oor vlak boven de mond en neus van het kind.
   • Luister of u een regelmatige ademhaling hoort zonder bijgeluiden.
   • Kijk of u de borstkas en/of de buik op en neer ziet gaan.
   • Voel of er uitademingslucht tegen uw oor en/of wang komt.

3. Controleer maximaal 10 seconden.

Als het kind normaal ademt, leg het kind dan op zijn zij →

Als het kind niet normaal ademt (of u twijfelt) en er is een omstander die kan alarmeren → of u bent alleen →

Figure 3.
The Dutch Paediatric Basic Life Support (PBLS) manual [30] Students have to make decisions all the time. Based on their decision, they navigate to another page.
(Reproduced with permission of the Dutch Resuscitation Council)

Retention and retrieval
Studies on the theoretical knowledge from life support courses have shown the same power-law curve of retention as the classical curve.[31] Studies on CPR and AED skills have shown that there is a difference between the retention of CPR skills and AED skills. Although data are lacking to construct a precise retention curve for CPR skills, there is conclusive evidence that CPR skills deteriorate within months of acquisition.[32-47] When the studies in this thesis were initiated, only one previous study had addressed the retention of AED skills.[48] Four others were published while the studies in this thesis were being carried out.[49-52] Most studies indicated that it seems possible that there is good retention of AED skills over a period of at least a year, although it was also found that time to shock increases over time by 3-13 seconds, and after seven months one third of the learners failed to perform adequate safety checks before a shock.[49,50] Since AED devices prompt the user to follow the correct algorithm, it might well be that these voice prompts act as a cue for correct retrieval.
Optimal retention is important for the use of CPR and AED since these skills may have to be applied unexpectedly and immediately, and skill retrieval has to be instantaneous, even in unfamiliar and stressful situations.

Thesis

Alternative methods of education have to be investigated to identify ways to increase retention of CPR and AED skills, to speed up retrieval of this knowledge, and to determine if they are more efficient and cost effective. The focus of this thesis is to investigate alternative learning models for CPR and AED use, keeping the different elements of the didactical models and the influence on retention and retrieval in mind. For most studies, data collection can only take place through retrieval and in simulated test scenarios.

Transfer model

The studies in Chapters 3 and 4 describe the results of instructor-led training; in Chapter 3 as the standard to compare the self-training methods, and in Chapter 4 as the effect of the learning result during real life events.

Independent learning model

The studies in Chapters 5 and 6 describe independent learning by use of a poster. This poster gave learners the opportunity to interact with each other, whilst still following a structured learning path. The poster is an example of a facilitating tool of the independent learning model.

Interactive learning model

Chapter 3 examines the learning efficacy of an individual training set, consisting of a simple manikin, together with a DVD featuring a demonstration and instructions. In the study, subjects were asked to watch the DVD and to practise the demonstrated skills. The learners used the materials in an active way. The guidance from an instructor in this method was not focussed on learning results but on the learning process. In the study described in Chapter 7, the learners were completely independent in their learning process with regard to time, place, and the way they navigated through the course materials, although they could contact the experts through the "Helpdesk" button.

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