Educational models: A case study into transferability of pedagogical structure in a complex learning object

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Learning objects in practice 3

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1 Introduction

This document investigates the possibilities for educational institutes to implement learning objects that have been developed elsewhere. An important factor is the usability from a pedagogical point of view: how can you adjust and transfer a learning object that is a unity of both content and pedagogy, to meet your own educational purposes? Another factor is teacher motivation to actually use the learning object: if adjusting takes as much (or more) time as developing a new learning object, then motivation will be lacking entirely. A possible solution might consist of formulating recommendations for adjusting learning objects, with the prior condition that these lead to raising teachers' motivation in developing and sharing learning objects.

These recommendations are based on (the description of) a case study, but they also offer practical guidelines. These guidelines do not always offer ready-made solutions; in some cases, providing a conceptual framework is sufficient. The subject of this case study is a pilot in which a complex learning object, developed according to a specific pedagogical model, is being implemented in a different pedagogical environment. Subsequently, the findings of instructional designers and teachers who are involved in the pilot offer sufficient background for a prescriptive instrument consisting of practical guidelines and mind sets.

2 Problem definition and intended results

According to David Merrill (2001, 2006), what is called a learning object is usually just a knowledge object, a coherent unity of loose bits of information (which he calls media objects, Figure 1). In these objects, the pedagogical aspect is altogether missing. An important distinction in this respect is the distinction between knowledge and pedagogical knowledge. In the case of pedagogical knowledge, aspects of learnability are taken into consideration so things like prior knowledge, learning goals and the appropriate pedagogical model will also play an important role. Therefore Merrill prefers to use the term 'learning objects' for large, complex tasks, rather than for objects containing loose bits of information. Learning objects in the form of large, complex tasks not only contain one or more of these loose bits (media objects), but also so-called strategy objects. Strategy objects can consist of a pedagogical structure, a learning task, learning goals and a test. In Merrill's view, a learning object always contains an instruction strategy. We will discuss a similar kind of pedagogical learning objects in this paper.

The problem we would like to address is the occurrence of obstacles one encounters when aiming to reuse a learning object in a pedagogical context different from the one in which it was designed to be used. The starting point is as follows: reusing learning objects is worthwhile because a relatively small investment in time can result in a high quality product. This is possible because you continue building on work of others. If adapting an existent learning object for your own purposes does not cost less time or result in better quality as compared to developing one yourself from scratch, then the most important criterion for reuse has not been met (Sloep, 2004). In other words: teachers will not be motivated to use the learning object.

A few remarks to set the right frame of mind for the following discussion

1. A piece of instruction will serve as a single learning object, unless one or more parts can be distinguished as usable on their own. If such is the case, the whole object will be divided into several learning objects (see Rasenberg, 2004, and Schoonenboom, 2006, for further discussion of this principle).

2. The scope of a learning object is a function of the pedagogical learning environment in which it is being developed and the pedagogical choices that are made.
3. The motivation to reuse a learning object is inversely proportional to its size (or complexity). Small learning objects can facilitate custom-made education more easily.

This document addresses the (im)possibilities of reusing a complex learning object in an pedagogical environment different from the one it was developed for. The learning object that is used in this case study is called 'Information Problem Solving'. To determine the usability of this learning object, it is important that the object be described at two levels, each with its own impact on the reusability of the learning object. On an abstract level, the learning object is based on a specific pedagogical model with specific assumptions about the way learners are supposed to learn. Following the model, the learning object is designed on a more concrete level to acquire its specific structure and content. Next we will discuss the pedagogical model on which the learning object 'Information Problem Solving' is based. After discussing structure and content of this learning object, we will look at several hypotheses about its reusability. The discussion about these hypotheses will lead to suggestions for reuse of complex learning objects and finally to guidelines for motivating reuse.

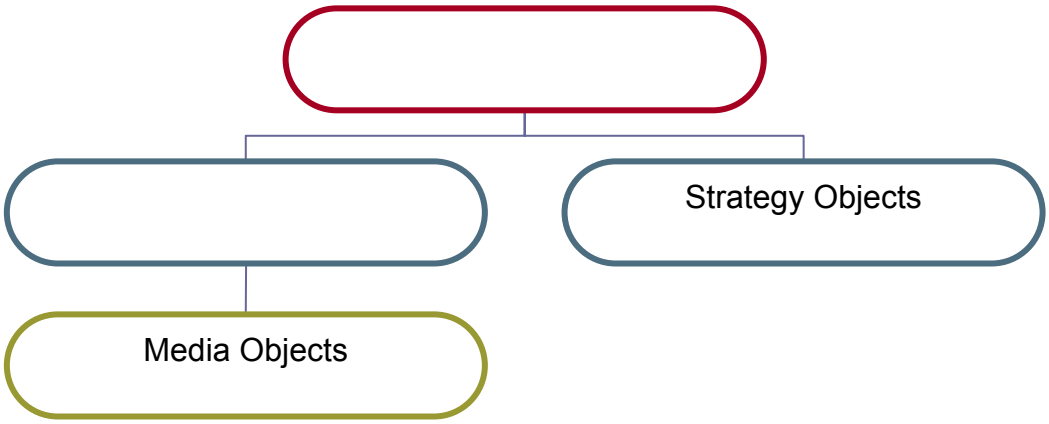

Figure 1. Learning objects according to David Merrill (2006)

3 The instructional design

This section discusses the pedagogical model on which the learning object of our case study: 'Information Problem Solving' is based. The pedagogical model at hand is the 'four components instructional design model', in short 4C/ID-model, for learning complex cognitive skills. The 4C/ID-model is a method for designing instruction to encourage learners' expertise in a certain area. The model offers guidelines that can be used in different contexts (Van Merriënboer, 1997).
The 4C/ID-model consists of four components: learning tasks, supportive information, procedural (just-in-time) information and subtask practice.

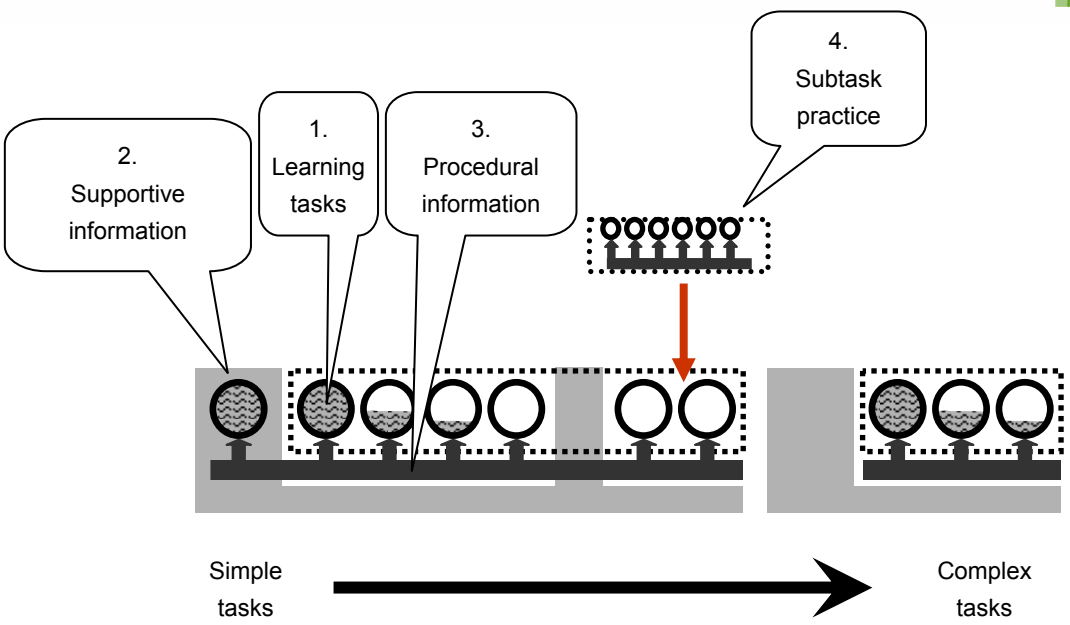

Figure 2. The four components of the 4C/ID-model (Van Merriënboer, 1997)

3.1 Learning tasks

Starting point is that learners learn by executing meaningful, integrative, authentic tasks. By carrying out these tasks, learners will practise a range of necessary subskills, attitudes and knowledge combined, and integrate them in their existing repertoire.

This requires a whole-task approach; recurrent aspects of performance are not trained separately but in the context of whole learning tasks. If there are several learning tasks (of similar complexity), control will decrease with each new task until the learner runs through the process autonomously. After a cycle of simple learning tasks, a cycle of more complex learning tasks can be completed in the same manner (Jochems, Van Merriënboer & Koper, 2004).

3.2 Supportive information

Supportive information consists of the knowledge needed to execute the learning tasks. It refers to information needed to fulfil non-routine aspects of a competency, the underlying heuristic skills. This model makes an important distinction between these non-routine aspects and routine aspects, the subskills that are executed according to rules or algorithms (Jochems, Van Merriënboer & Koper, 2004).

3.3 Procedural information

Procedural information concerns the information needed to learn and execute routine aspects of learning tasks. Preferably it is offered when learners actually need it (just-in-time). The skill is practised until it is mastered as a routine. Procedural information is available during the whole learning task (Jochems, Van Merriënboer & Koper, 2004).

3.4 Subtask practice

Subtasks aim to practise certain sub-aspects of complex skills in order to reach automatism. An example of a subtask is practising scales as an addition to playing or singing songs (Jochems, Van Merriënboer & Koper, 2004).

4 The learning object

In this paragraph we explicate content and structure of the learning object 'Information Problem Solving'. This learning object is a piece of instruction built according to the 4C/ID-model that we discussed in the previous paragraph. The learning object is quite complex in structure as well as content. As the name implies, it is an instruction to learn, practise and test the complex cognitive skill of solving information problems. This skill is complex because it consists of several parts that can be executed in a linear as well as an iterative way. The parts of the instruction are described within the pedagogical model as more or less separate skills, each with its own hierarchical structure of subskills.

The learning object 'Information Problem Solving' was developed by adapting an existing course in psycholinguistics of teacher-training Dutch for secondary education. Original learning goals of this course were: obtaining theoretical insight in psycholinguistics combined with the knowledge and skills needed to inform colleagues and parents about the subject. The resulting new course psycholinguistics was set up according to the 4C/ID-model with information literacy skills integrated. Obviously, the original learning goals were maintained.

The course in psycholinguistics was composed of four learning tasks (similar in complexity) of which the first was a modelling example. This modelling example was executed in front of the learners in order to solve the first information problem. Learners then executed the three consecutive tasks, each of which with a decreasing amount of control. The fourth and last task was to be executed by each learner autonomously. All three tasks executed by the learners resulted in a product: a flyer, a folder and a brochure about one aspect of psycholinguistics respectively. When assembling these products, original learning goals as well as information literacy skills were addressed. Through content and presentation of the products, mastering of the aforementioned goals and skills was assessed.

The instruction 'Information Problem Solving' can be described in a hierarchical structure of three levels. Level 1 contains the whole instruction as a learning object, level 2 contains the three parts that the instruction consists of, and level 3 contains several sub-parts within the parts of level 2 (see Figure 3).

The diagram below illustrates the hierarchical structure. We see, for instance, that executing Phase 1 from Task 1 of the Workbook is connected to Chapter 3 of the Theory book whereas Phase 2 is connected to Chapter 4. This shows that the whole instruction is a complex learning object: even where you can distinguish smaller learning objects on the lowest level, there is still a certain interdependency between parts from different levels of the instruction.

4.1 Level 1

At the highest level, the whole instruction 'Information Problem Solving' can be described as a learning object (after decontextualisation).

4.2 Level 2

At the second level, the three parts of which the instruction consists can be described:

- the *Manual for teachers* and instructional designers, which can be used independently from the learning tasks (instruction component or strategy object);
- the *Workbook for learners* which contains the four subsequent learning tasks;
- the *Theory book for learners* which contains the theoretical part of information literacy, to be consulted by learners whenever needed (just-in-time).

4.3 Level 3

At the lowest level, the smallest independently usable parts that still have a pedagogical context can be described. These are, for instance, the chapters in the Theory book that address skills that can be studied independently, though usually in connection with other chapters. Examples are the chapters ‘Using the catalogue’ and ‘Defining the information problem’.

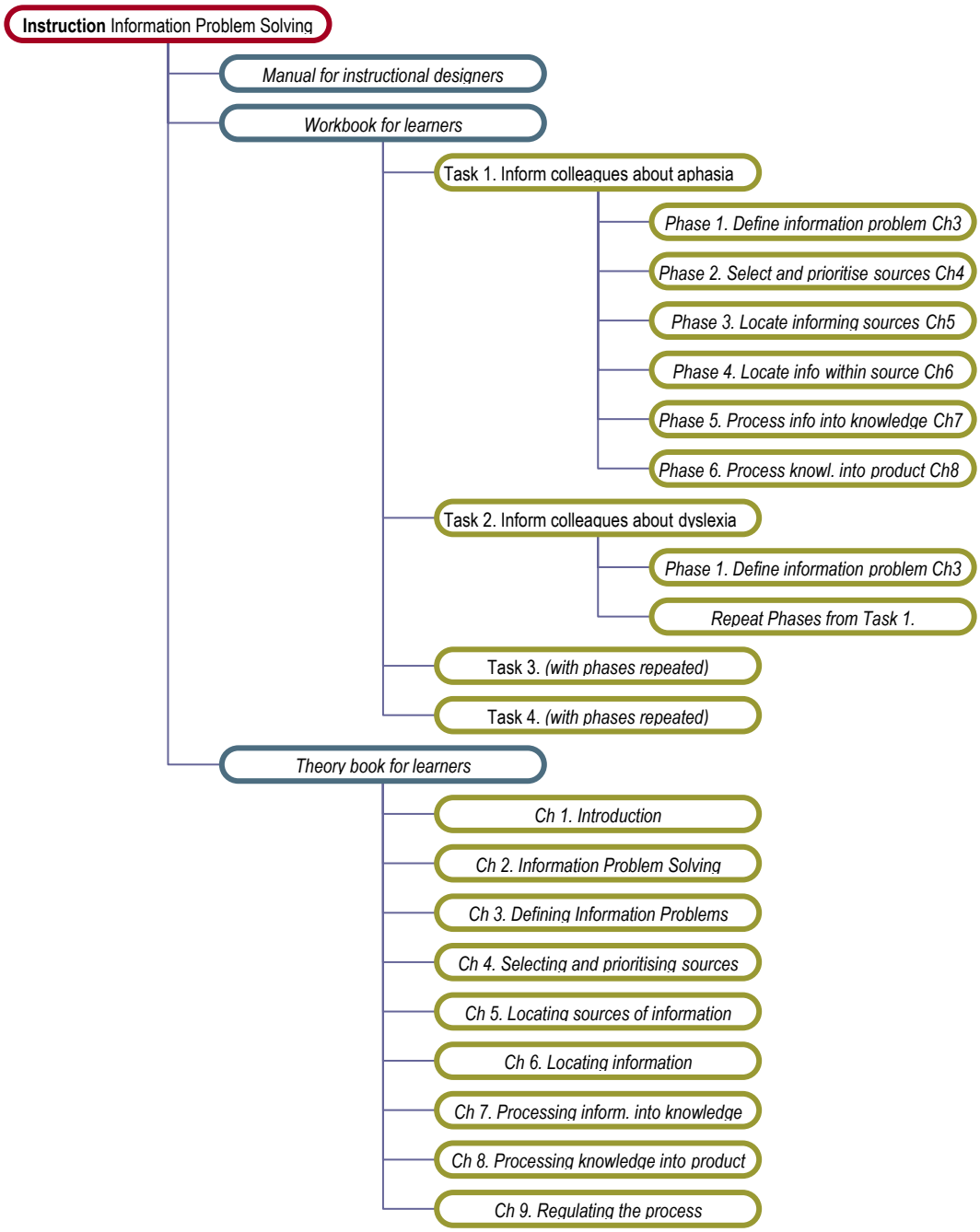

Figure 3. Hierarchical structure of the learning object ‘Information Problem Solving’ – the largely generic information is represented in italics (level 1 of the whole instruction top left, level 2 in the second column, and level 3 in the third and fourth column)

5 Hypotheses concerning interchangeability

To form an opinion about the possibilities of reusing this learning object, it is important to establish whether the instruction always is to be used as a whole. Perhaps it is possible and advisable to use parts of the instruction independently from the whole object. Actually, we need to establish the level at which several practices and learning materials within the object can still be called learning objects in their own rights. To assess this, we first use the criterion of pedagogical context: only when separate elements of the instruction still hold a pedagogical context, we can consider them learning objects. The second criterion would be whether these elements can be used independently.

And then there is another question to be addressed, linked to the problem definition of this case study (Chapter 2):

> *"The size and scope of a learning object is connected to the pedagogical environment and pedagogical choices within which it was developed, used, and will be reused. Ideally, a learning object is adaptable to the individual and specific needs of teachers and/or learners".*

5.1 Presumed interchangeability of the whole learning object

The instruction as a whole meets the criteria for being regarded a learning object. There is a clearly described pedagogical context by way of a pedagogical model and the instruction can be used independently. The instruction was tested in a pilot study at a university for professional education (teacher-training Dutch for secondary education). It was adapted to be used with a Psycholinguistics course and contains contextual content in the Workbook for learners.

The *Manual for teachers and instructional designers* seems sufficiently generic to reuse the instruction without alterations with the same or another teacher-training institute. Only another pilot study could provide a definitive answer. In principle, the instruction can be used in any teacher-training course on a professional education level. In order to use the instruction, the teacher needn't have any prior experience with the 4C/ID-model. The goal of the instruction, reaching a certain level of information literacy, is an extra goal next to the course's goals. Therefore, and because the content of the Theory book is fixed, it is not necessary that specialist information literacy teachers be involved. No adaptations in other parts of the pedagogical environment will be necessary.

In order to reuse the learning object, some parts will have to be decontextualised. The Manual for teachers and instructional designers contains specialist instructions that apply to the course in Psycholinguistics only. These need to be substituted by specialist instructions for the course in which the learning object will be reused. The Workbook also contains introductions to the tasks for the course in Psycholinguistics and some course specific questions that need to be substituted.

5.2 Presumed interchangeability of the learning object's three parts

All three parts of the instruction at the second level (Manual, Workbook and Theory book) can be used independently to a certain extent. They all have a recognisable pedagogical context.

a. The Manual explains the pedagogical model (4C/ID-model) and its utilisation in the curriculum.
b. The Workbook contains specific content for every task (which is to be substituted) and a generic framework for executing and reporting the tasks.
c. The Theory book offers the procedural information which is applicable for every learning task that contains an information solving problem.

For instance, the Manual can be used apart from the other components of the instruction to develop a new instruction based on the 4C/ID-model. The Theory book can be used as background information with another course in information literacy. However, using only the Workbook requires

prior knowledge of the 4C/ID-model and the use of some background material in information problem solving. In order to correctly use the instruction according to the 4C/ID-model, it is necessary to use all three components as intended.

5.3 Presumed interchangeability of the learning object's respective chapters

a. The Manual cannot be divided into smaller learning objects without losing coherence. Therefore, the Manual has to be regarded as an indivisible learning object.
b. The Workbook has a primary subdivision into separate learning tasks and a secondary subdivision into learning phases. Tasks as well as phases have a distinguishable pedagogical context but are not very suitable for independent use as they lean very heavily on content. However, the parts in the Workbook that have to be filled in by learners are largely decontextualised (except for where there is still some control). Concluding: with respect to interchangeability, parts of the Workbook stop at level 2, whereas other parts might be considered as separate, smaller learning objects at level 3. Please note that in using these smaller parts independently, many pedagogical aspects of the 4C/ID-model and references to the Theory book will be lost.
c. The Theory book can be subdivided in a number of chapters with different subjects. There still is a pedagogical context because something can be learned or practised. One can choose to use only chapters that add to a certain learning task. The just-in-time information in the Theory book allows learners to pick the chapters they need at a given moment. Concluding: the Theory book can be subdivided into learning objects on level 3 that can and will be used independently.

6 Method of study into interchangeability in practice

We have established how the learning object based on the 4C/ID-model can be subdivided in smaller learning objects. Now we will focus on how to persuade teachers to reuse the whole learning object or its parts. What guidelines or practical help can be formulated to motivate teachers in reusing this instruction? We studied its interchangeability in practice through a pilot study, using the following methods:

1. The instruction was used in a course at a teacher-training institute with a different focus ('Men & Society);
2. Teachers involved in developing and using the original course (Psycholinguistics) were asked about their experiences with adapting the course to the pedagogical structure of the learning object (the 4C/ID-model);
3. Instructional designers of the learning object were asked about the choices they had to make while designing the instruction, as far as these concerned problems to be expected with reuse.

7 Results of study into interchangeability in practice

We will describe the results of the study into interchangeability following the above method. First we tried to execute the study exactly as proposed. In a first round of questioning, we made requests to teachers and asked questions to all those involved. When the first point of action (reusing the existing instruction -see 6.1.) was about to fail, the answers from action points 2 & 3 led us to alter the initial request for a second round of questioning. We hoped this new request for reuse would be acceptable for all teachers involved.

7.1 The learning object

There have been attempts to reuse the learning object (the instruction Information Problem Solving) with a course on teaching practice at the teacher-training institute called Men & Society. The three

teachers involved have laboriously discussed how the existing instruction might be implemented with the teaching practice course they use for their first-year students.

Following is the initial reaction of the teacher responsible for the course:

> *In the past three years, the value of the current course of teaching practice has been proved. Adapting it to the terminology of the instruction Information Problem Solving is not considered expedient at this moment because of the somewhat abstract language that might deter learners and consequently prove counterproductive. Furthermore, a second and less important argument, the participating teachers lack the time to thoroughly revise the course description because of other team- and institute priorities.*

The teacher's reaction supports the opinion that learning objects can be larger and more complex if the learning itself becomes more complex. The teacher thinks the complex learning object at hand aims too high for his first-year students.

Second round:
Our new and adapted goal is to implement the learning object in phases, spread over four learning tasks in the first year. During each of these tasks, the whole process of information problem solving (Figure 3) is walked through by the learner. The first task takes the learner by the hand through the process. Certain sources of information will be made available to be consulted and processed into a product. This control will decrease during tasks 2 and 3. Task 4 has to be executed completely autonomously by the learner. The procedural information in the Theory book is always at hand; the separate chapters will be integrated as hyperlinks into the tasks' introduction. The eventual product from task 4 is supposed to demonstrate the learner's information literacy skills.

Furthermore, an ICT learning course with performance indicators for every level of mastering ICT skills is being worked upon. The level that should be reached at the end of the first year will be determined around Fall 2006.

7.2 The teachers

We posed the following questions to a teacher who was involved in the design and implementation of the original course in Psycholinguistics (in which the instruction Information Problem Solving was integrated):

1. Which adjustments have been necessary to make the course suitable for the instruction?
2. How and to what extent have these adjustments influenced the course?
3. Looking back, were these adjustments worth your time and trouble?

Sub 1. The choice for this course (Psycholinguistics) was dictated by its clearly pedagogical, or rather, professionally relevant context. The learning task focused on two subjects: language acquisition and dyslexia, both clearly relevant subjects from a professional point of view. The teacher was rather pleased with the content and structure of the original course but also considered it a challenge to participate in another approach to learning.

The most striking adjustments were:

- Independent searching for and handling of digitally presented information were heavily emphasized;
- The teacher felt redundant in his capacity of professional information provider because there was room for two formal lectures only on the subject of dyslexia;

- The concept of authentic, professionally relevant learning tasks, as present in the existing course, became more concrete with the new course.

Sub 2. The original course had been influenced as follows:
- Contact time between teacher and learner, which is of the utmost importance in teacher-training institutes, was greatly reduced;
- The knowledge of an enthusiastic teacher can inspire learners. During a formal lecture, the teacher will make learners think, and lively interaction between teacher/learner and among learners will arise. According to the teacher involved, the pilot study largely lacked this aspect;
- Too many adjustments had to be made in too little time, causing even more decrease in interaction with learners.

Sub 3. For all the above reasons, the first impression right after finishing the course, was that teachers involved did not find the adjustments to the course altogether worth their time. Looking back 18 months after finishing the course, the interviewed teacher is able to differentiate his opinion.
- From the existing course on paper, next to nothing was useful in the new, adjusted course. In fact, only the subject of the course was maintained.
- The teacher considered information literacy to be a fundamental skill of the utmost importance and therefore was inclined to adjust the original course to the instruction. After finishing the pilot, the teacher proposed to start using the instruction with all first-year students.

The teacher involved also gave comprehensive advice as to how – in his opinion - the learning object might be implemented with greater success and less frustrations for the teachers involved. This advice shows that the teacher considers the content of the learning object very useful, but would rather see it implemented without the strict pedagogical guidelines of the 4C/ID-model.

Second round:
We have asked the same teacher's opinion about using the learning object in the above mentioned adjusted manner, spread out over several courses within the first-year course.
The teacher's answer:

> *Organising information literacy in phases with the instruction at hand seems fine to me: going from major control in the beginning (modelling example) to decreasing control in the last period of the first-year course. Knowing that first-year students have very little experience with educational practice, I wouldn't complicate this task by fleshing it out in a strongly pedagogical way (although this would be an absolute condition in a later stage of the study). Content of the instruction at hand should be mainly professional, linked to the existing curriculum. Let it be part of and integrated in existing courses so that it will not be experienced as a foreign element. Information literacy is a fundamental studying skill that cannot be disregarded anymore but should constitute an integrative part in the whole course.*

The last remark does quite conform to the above mentioned ICT learning course under construction (see 8.1)

7.3 The instructional designer

The designer of the instruction (the learning object) divides this into:
- A self-instruction for teachers;
- A framework (the decontextualised Workbook plus the Theory book);
- A worked-out example (the Workbook with context)

From the Manual 'Information Problem Solving':

The 4C/ID-model offers guidelines to design educational tasks for learning complex cognitive skills. When applying the model, a number of steps can be taken to integrate the skill 'Information Problem Solving' thoroughly in the curriculum. These steps will be elaborated in the following paragraphs. The educational course that was designed for use at the Fontys Teacher-Training institute will be used as an example. Finally, guidelines are formulated for teachers and instructional designers who wish to integrate information literacy skills in their curriculum. An overview of steps is given before the subsequent steps are elaborated. Figure 4 shows the steps and substeps.

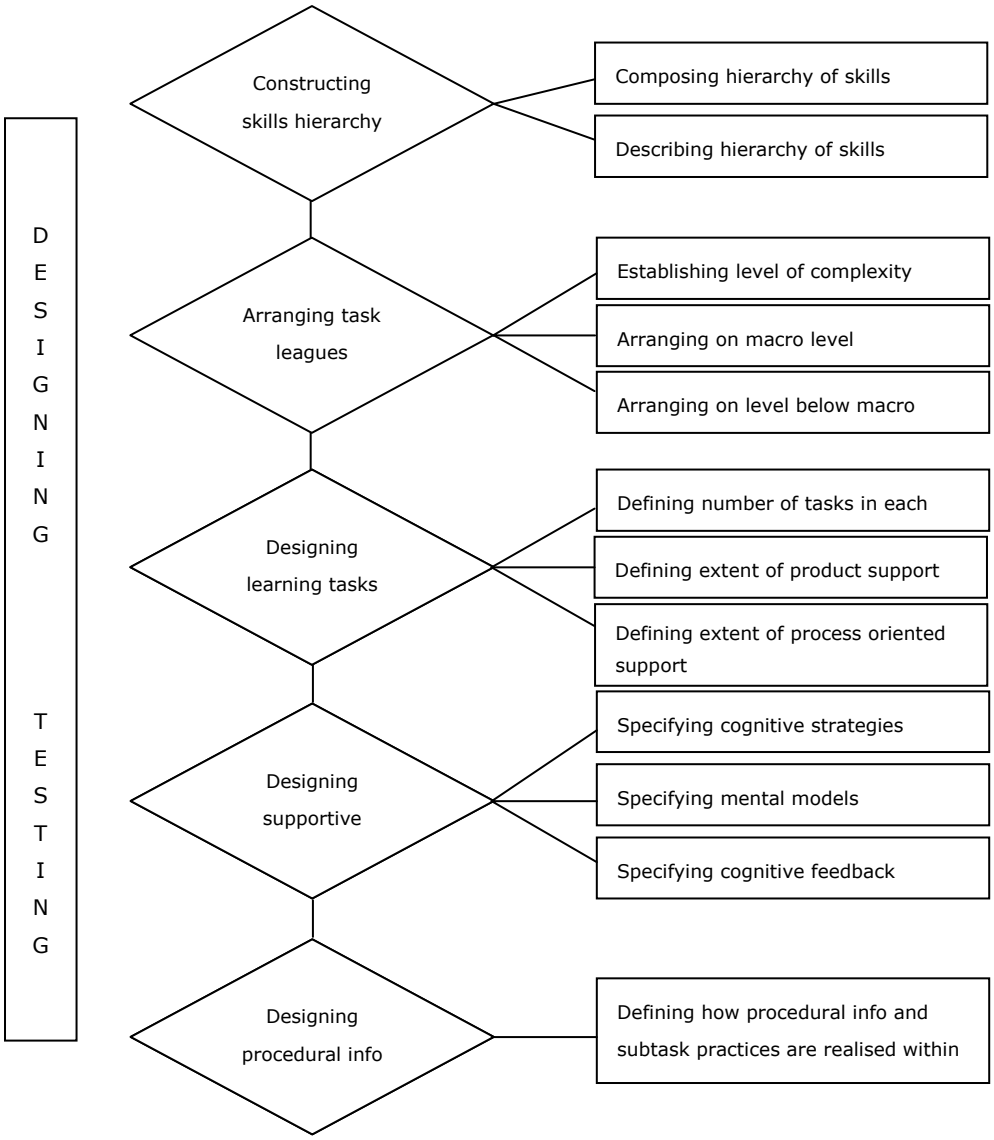

Figure 4. Steps to be taken in order to integrate 'Information Problem Solving' in the curriculum

Elaboration of the steps suggests a significant investment in time for both teacher and user. In order to make full use of the advantages of applying the 4C/ID-model, the teacher will have to acquaint him/herself with the model. Some remarks about this:

- First use of the 4C/ID-model will obviously be easiest when following a directly applicable example such as the instruction at hand;

- Subsequently, implementing the same instruction based on the 4C/ID-model, will be easier to realise as a number of the steps from Figure 3 will already have been taken;
- When designing a different course from the 4C/ID-model, the steps will have to be worked through in order to obtain an adequately constructed course;
- The steps are decontextualised and easy to reuse. The focus is on integration of the skills to be practised in a particular part of the curriculum. On the other hand, the learning object without the context will become more abstract and less clear in its possibilities for reuse.

We asked the instructional designer of the learning object (the instruction based on the 4C/ID-model) which choices were made when designing the instruction. The design aims at an ideal situation, the designers knew from the start that the instruction would never be used in this ideal (laboratory) form. Not only the objections from the teachers who had already worked with it, but also the hesitations of the teachers who were supposed to reuse the instruction suggest this much.

An important question therefore is: to what extent are the partial learning objects in which the learning object can be divided, reusable without abandoning the typical pedagogical structure? The answer conforms to what was mentioned earlier on interchangeability at various levels. In fact, the Theory book for students is the only partial learning object that seems to be usable independently from the other parts. Some loose chapters from this Theory book could also be used as partial learning object to explain small subdivisions of theory. However, pedagogical coherence will be completely lost.

On the other hand, it is possible to abandon certain components of the 4C/ID-model, for instance using different learning tasks of equal complexity. According to the instructional designer, the pedagogical model will hold even if there is only one learning task, given that the other components are used. From these, even the component part tasks practice could well be left out without essentially affecting the pedagogical structure. This leads us to the paradoxical conclusion that in this case the pedagogical model seems to be more flexible than the instruction that was based on the same model.

Second round:
To the instructional designer, we have proposed the teachers' plan to reuse the instruction in parts spread over several learning tasks during the first-year period. In each of the learning tasks, students work autonomously with a simplified version of the Workbook combined with the whole Theory book. The aspect of decreasing control is maintained and focus will still be on student self regulation. The tasks will be strongly heterogeneous in arrangement and level of complexity.

The designer is very positive about implementing the information literacy instruction with decreasing control in phases throughout the first-year period. It is however important to keep using realistic whole tasks that comprise of the entire process. The designer offers some additional points of interest regarding reuse of the learning object, resulting from hiatuses that occurred during further study.

8 Guidelines for reusing learning objects

Implementation of the learning object from this case study seemed to be restrained by several factors that initially forced the teachers involved to reject reuse. Next, we tried to stimulate the motivation for reuse by making concessions and by reinterpreting the learning object's demands towards the learning task in which it was supposed to be implemented. Tentative results are that the learning object will be reused in an adjusted form, which is acceptable to all those involved.

Restraining factors as well as adjustments and concessions will offer guidelines for development and reuse.

Discernable obstacles with the described learning object are:

1. lack of time to implement a complex learning object
2. level of complexity in relation to level of learning
3. competition with other parts of the course
4. insecurity about usability
5. oppressing pedagogical structure
6. (lack of) flexibility
7. (lack of) vision to transform ideal design into usable learning material

8.1 Guidelines resulting from obstacles

1. Complex learning objects should be planned for well in advance and even more so if they strongly depend on an 'alien' pedagogical context. Indicate how strongly their content depends on the pedagogical context and which measures are necessary to implement this new content in the pedagogical context already in use. If possible, also indicate the time investment needed.

2. Tune the complexity of the learning objects to the level of learning on which they will be used. Check the level of abstraction and make sure it is not too high for the learning goals and the learners intended. Disadvantage: a low level of abstraction renders the learning object less flexible.

3. Clarify the structure so that it becomes instantly clear where the learning object can be fitted in with other parts of the course.

4. Mind the use of language when introducing the learning object. Chances of acceptance will increase if the way the meaning of the learning object is worded links up with the intended user. Make use of metadata to indicate for which learning environment and level of learning the learning object at hand is most suitable.

5. Explain how and where the pedagogical structure is crucial for the learning object. Indicate which content can be used independently from the pedagogical context and why.

6. Clarify which parts can be used independently and in which way. Offer advice (if possible) as to how the learning object can be used within a different pedagogical context.

7. Make clear what is typical for the learning object and should therefore be maintained when reusing. Indicate where and how the learning object can be adjusted or simplified and advise on these adjustments. If it is possible to implement the learning object in phases, the basic structure should be clear to future users. Also see 8.3, point 2.

8.2 General guidelines

Not so much technology but human aspects determine the possibilities of learning objects. Most important factors are: transparency, size and flexibility. The learning object should be transparent in content, level, structure and usability. The learning object should be small enough to fit into any course or learning task, and big enough to have 'meaning for learning'. The context in which the learning object was developed appears to be of minor importance. The desirable flexibility is at odds with the possible pedagogical context of a learning object. Perhaps it would be wiser not to

consider the whole instruction at hand as a learning object, but only those parts that can be used independently from one another.

Learning objects should be 'just enough' – if you only follow part of the course, you can use the exact learning object you need. They should be 'just-in-time' – available and traceable when you need them. They should be 'just for you' – intended for made-to-measure courses to suit organisations or individuals. (For example: WISC online - Wisconsin Online Resource Center, a free digital repository of Web-based learning resources called learning objects, designed and developed by a team of instructional designers, editors, technicians, and student interns).

1. In learning tasks based on a constructivist theory, be sure to assign a mainly supporting role to learning objects.

2. Try to build in the possibility to break up the learning object into meaningful pieces and annotate the points of interruption for the benefit of current and future users. That way, the learning object as a whole will stay intact and can be implemented more broadly without the user actually adjusting it (or damaging it).

3. Use learning objects as small elements of control in innovation. Teachers and instructional designers are inclined to apply innovations on a small scale rather than on the whole curriculum.

8.3 Mind sets

The way in which a learning object is introduced and the way in which the meaning of the learning object is expressed, are very important for acceptation. The word 'object' implicitly carries the meaning: visible, concrete and stabile. The danger with metaphors is that human knowledge and communication are being oversimplified.

1. Learning objects as Lego bricks (Hodgins, 2002): suggests that they can be combined with any other learning objects, that they fit together in various ways and that they are very easy to use. To say the least, this is rather misleading when it comes to portability .

2. Learning objects as molecular structures (Wiley, 2002): atoms can only be combined significantly with a limited number of other atoms. Their internal structure prescribes these possible combinations. The complexity of molecular structures thus reflects the complexity of learning objects. Still, this metaphor implies a limited set of rules and algorithms for possible combinations that does not match the dynamical and infinite nature of knowledge.

3. Learning objects as editing of film images (Parrish, 2004): a film is composed of time segments (like music) but at the same time it is physically assembled from separate images that become shots, scenes and acts in successive combinations. These combinations are almost endless and each of them has a unique effect on the viewer. Besides, cultural standards determine how a story should be told in images and what kind of editing might be effective to that. Although still a metaphor and thus by definition inadequate, this description comes close to how one can and cannot reuse learning objects.

9 Conclusions

An important criterion for reuse is to what extent a complex learning object based on a pedagogical structure can be adjusted. These adjustments could concern content of the learning object (part

versus whole; simplification, use of language) as well as pedagogical structure (which part of the new pedagogy is inextricable and which part could be given up in favour of current pedagogy).

An important criterion for reuse is to what extent a learning object based on a pedagogical structure fits in with current parts of the course. This connection could concern content as well as level.

The way in which a learning object is introduced and the way in which the meaning of the learning object is expressed, can highly contribute to teachers' motivation to reuse the object.

In short: the ideal learning object based on a pedagogical structure can be made to measure, connected to level, and is available at any time at any place. Moreover, all these criteria should be clearly stated and expressed before reuse of the learning object.

The problem definition from section 2 seems to concur only partly with the results of the case study. A learning object does not necessarily have to be small in size and/or simple in structure to be reused. Teachers' motivation is dependent on several factors. These factors vary when the learning object becomes larger or more complex.

The pedagogical context is better preserved in the sizeable, complex learning object that derives its motivation for reuse mainly from clarity concerning a) connection on the right level to other parts of the course and b) implementation in parts or in phases. The pedagogical context and consequences when used in a course based on a different pedagogy, should be made well visible before offering a sizeable learning object for reuse. Important factors will be the time involved with making necessary adjustments and the level of abstraction (in both content and language).

If a learning object is small in size, implementation will be easier. A drawback is that a possible pedagogical structure will be less compelling and easier to let go. In that case, it is important that crucial items in the pedagogy used are stated explicitly before offering a small learning object for reuse. An important factor will be the way in which several (partial) objects are made available (metadating for instance).

Finally, motivation for reuse is influenced by personal factors. Presumably, teachers will be less inclined to reuse a complex learning object that is taken without any further introduction from an external database, than a learning object that is taken from an internal (institutional) database and/or introduced or even recommended by peers. It is difficult for teachers to assess the quality of learning objects from outside their own educational institute. This represents an obstacle in the use of external repositories.

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Appendix: Model 'Information Problem Solving'