## Deliverable 2.1

Pedagogical Ontology

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1 R=Report, P=Prototype, D=Demonstrator, O=Other
2 PU=Public, PP=Restricted to other programme participants (including the Commission Services), RE=Restricted to a group specified by the consortium (including the Commission Services), CO=Confidential, only for members of the consortium (including the Commission Services)
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Appendix A - Possible Extension of the Knowledge Type and Media Type Vocabulary

Knowledge Type Vocabulary

Receptive Knowledge Type

Interactive Knowledge Type:

Cooperative Knowledge Types:

Media Type Vocabulary

Communication:

Presentation:

Interaction
1 Introduction
This document specifies the pedagogical ontology for INTUITEL. The OWL ontology will be based on the ontology specification which will be used for two purposes:
1) The OWL ontology will be based on the ontology specification. The OWL ontology and the learning pathways defined in the ontology will be used by the INTUITEL Engine to create adaptations and recommendations for the learner.
2) The specifications will be used as a guideline for authors who create content for the knowledge domains.

The specifications are based on the pedagogical ontology as published by Meder (2006) “Web-Didactics”. The purpose of the ontology developed by Meder was to create a metadata system and a vocabulary that is suitable to express every learning pathway that has been applied in the history of education. While the ontology was developed as a general approach for all teaching and learning situations, it has been specified for online distance learning environments. To do so, considerations from media theory were combined with concepts for knowledge organisation from information sciences and educational theories.

The ontology for INTUITEL is based on the following assumptions:
- Teaching and learning depends on heuristics that are based on authors and learners experiences and cultural backgrounds.
- The production of e-Learning material is costly.
- Managing a large number of learning pathways is difficult for authors and learners.
- The production of learning environments is a professional activity that cannot be conceptualised into a rigid system.
- A reasonable granularity of learning material is required to be able to generate a comprehensible classification that is used for adaptations, recommendations and individual learning.
- Learning on individual pathways should be possible for every learner.

Thus the learning pathways in INTUITEL should be clearly different, cover different teaching and learning cultures, and they should offer flexibility not only to learners, but also to teachers and the INTUITEL engine.

To meet these demands two exemplary learning pathways were chosen: Inquiry Based Learning (IBL) and Multi Stage Learning (MSL). IBL can be characterised as a constructivistic approach and is similar to learning from best practice examples, to learning from own research activities, or problem based learning. MSL can be
characterised as a behaviouristic approach and is similar to "Frontalunterricht" in German speaking countries. In INTUITEL, IBL and MSL can be used in a flexible manner, since the learning pathways are not fixed in the metadata system, but created by the authors while producing the learning material. Thus, certain steps can be omitted from or added to the pathways; for authors and learners it is even possible to create completely new pathways. This is derived by (a) offering relation types to authors that are used to create the actual learning pathways and by (b) offering the metadata classifications to learners for individual navigation. In conclusion, this means that in INTUITEL there is the possibility of an extension to other learning pathways but to begin with MSL and IBL have been chosen.

This flexible structure is combined with a classification on three levels: Knowledge Domains (courses), Concept Containers (topics), and Knowledge Objects (screen page). Higher levels (modules, study programs) were not considered since none of the LMS applied in INTUITEL is capable of managing a common knowledge repository. Lower levels (small pictures or single text paragraphs) are not considered since all of the LMS applied in INTUITEL are page oriented and the adaptation would become too complex.
2 Terms and Definitions

2.1 Learning Object (LO)

2.1.1 Orientation

![Figure 1: Learning Objects](image)

2.1.2 Explanation

Learning Objects include instructional scaffolding such as learning objectives and outcomes, assessments, and other instructional components, as well as information objects (Metros, 2002). INTUITEL will accommodate Metros dimensions of learning objects by using three types of Learning Objects:

1) Knowledge Domain (Course Level)
2) Concept Container (Lesson Level)
3) Knowledge Objects (Content Level)

Thus, Learning Objects contain Learning Objects of different types.
2.2 Knowledge Domain (KD)/Course Level

2.2.1 Orientation

Figure 2: Knowledge Domain

2.2.2 Explanation

The term knowledge domain in general refers to the part of the world investigated by a specific discipline.

In INTUITEL, the term Knowledge Domain refers to a certain amount of knowledge, which is defined by a specific curriculum, syllabus and/or course requirements. In INTUITEL four partners (IOSB, URE, UVA, UVIE) will provide four Cognitive Models of four different Knowledge Domains, which correspond to the different example courses of INTUITEL\(^3\). Knowledge Domains consist of several Concept Containers. Course is a synonym for Knowledge Domain.

Knowledge Domains have a title, a description and consist of Concept Containers.

2.2.3 Example

Course: Philosophy of Didactics
Philosophy of Didactics consists of Comenius (Johann)
Philosophy of Didactics consists of Dewey (John)
Philosophy of Didactics consists of Klafki (Wolfgang)

\(^3\) For further explanation see chapter 2.6 KD and CC for Cognitive Models
2.3 Concept Container (CC)/Lesson Level

2.3.1 Orientation

Figure 3: Concept Container

2.3.2 Explanation

A Concept Container is a container for one or more Knowledge Objects (KO) which can be allocated to one or more Concept Containers. In INTUITEL one Concept Container contains one instructionally framed concept within a Knowledge Domain. Concept Containers are part of a Knowledge Domain. Concept Containers are:

- linked by typed relations within the Knowledge Domain
- assembled and structured corresponding to the logic of different pedagogical models that are derived from Learning Pathways and expressed by the typed relations.
  - learning pathway: hierarchically bottom up,
  - learning pathway: hierarchically top down,
  - learning pathway: chronologically from new to old;
  - learning pathway: chronologically from old to new

Concept Containers have a title, typed relations to other Concept Containers, are part of a Knowledge Domain, and consist of Knowledge Objects.

2.3.3 Example

Dewey (John) is part of Philosophy of Didactics.
Dewey (John) is chronologically after Comenius (Johann).
Dewey (John) is chronologically before Klafki (Wolfgang).

2.4 Knowledge Objects (KO)/Content Level

2.4.1 Orientation

In INTUITEL a Knowledge Object (KO) is an item of knowledge, which typically corresponds to one screen page of content and to an estimated learning time of 3-10 minutes for the average learner. This can be used as a fixed timeout after which INTUITEL assumes that there is some deficiency. A KO does not always correspond to learning content but also to learning activities. The description above is an orientation and contents or activities that take longer or involve more than one screen page, and cannot be split into smaller objects, can also be considered as a KO.

For example: In an Inquiry-Based-Learning Pathway (for more detail, see: Microlearning Pathways – Inquiry-Based-Learning) the students collect research results (for example, results from measurements of a frequency spectrum). These results might be fed into a database by the students. In this case, the database is used as a KO with media type text and knowledge type EvidenceAssignment in the Inquiry Based Learning Pathway.

The content of a knowledge object can be anything such as
- a discussion in a forum
  [
  → Knowledge Type: discussion,
  → Media type: text],

Figure 4: Knowledge Objects
- an assignment where a video has to be handed in
  \[\text{→ knowledge Type: hand in assignment,}
  \text{→ media Type: video}\] or

- reading an explanation
  \[\text{→ Knowledge type: explanation,}
  \text{→ Media type: text}]\.

Knowledge Objects are assembled and structured corresponding to the logic of different pedagogical knowledge Type models and media Type models that are derived from learning pathways.

→ learning pathway: Multi-Stage Learning,
→ learning pathway: Inquiry-Based Learning;
→ learning pathway: Concretising,
→ learning pathway: Abstracting.

Knowledge Objects have a learning time, a level\(^4\), a Knowledge Type, a Media Type, are part of a Concept Container and consist of content.

### 2.4.3 Example

Knowledge Object is part of Comenius (Johann).
Knowledge Object has Knowledge Type single choice assignment.
Knowledge Object has Media Type text.
Knowledge object has content:

| If the paper is purer, the print will be clearer. What does Comenius mean with this metaphor? |
| () Answer A: ... | () Answer B: ... | ()... |

Table 1: Example Knowledge Object

### 2.5 Summary of Meta Data and Pathways of Learning Objects

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<td></td>
<td></td>
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<tr>
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\(^4\) Beginner (First Level), Intermediate (Second Level), Advanced (Third Level)
Knowledge Object (KO) | • Learning time  
• EQF level  
• Knowledge Type  
• Media Type  

| • MSL  
• IBL  
• Concretising  
• Abstracting  

### 2.6 KD and CC for Cognitive Models

The knowledge domains and concept containers that are planned for INTUITEL are:

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<th>University of Reading</th>
<th>University of Vienna</th>
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| **Concept Containers** | Functional Principle of a Radar System; The Pulse Radar Method; Radar Types; | Classful IP addressing; Subnetting; Variable Length Subnet Mask (VLSM) | Software Design  
Object Oriented Programming  
Aspect Oriented Programming | Dewey (John); Comenius (Johan); Rogers (Carl) |

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<th>IP-Networking</th>
<th>Computer Programming</th>
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**Table 2: Cognitive Models**

It is likely that the concept containers will be adopted during the course of WP 2.2.
3 Macro Learning Pathways

3.1 Introduction

The Macro Learning Pathways describe how the learner might proceed between Concept Containers within a Knowledge Domain. The individual KO and CC sequences are assembled by the Back End in accordance to the Learning Pathways (LP).

The Macro Learning Pathways are on the level of the Concept Container within one Knowledge Domain. Within one Knowledge Domain, there can be more than one Concept Container (CC). These CCs are assembled and structured by learning pathways. The pathways are expressed by typed relationships. In INTUITEL there are four Macro Learning Pathways:

- Chronologically from old to new
- Chronologically from new to old
- Hierarchically top down
- Hierarchically bottom up

The structure of the pathway follows a logical structure, which is given by the author of the content of a Knowledge Domain.

3.2 Chronologically from old to new

The pathway “chronologically from old to new” is describing the structure for the Content Containers, which is following a timeline. The timeline is linear and is starting at the first Content Container, which is “the oldest”. The next step within the pathway would be going further to the next Concept Container, which is clarified as chronologically after the last Concept Container (for example: John Dewey is chronologically after Johann Comenius) and so on. The pathway ends as the last Concept Container is reached. The last Concept Container is the newest in the timeline.

Figure 5: Chronologically from old to new pathway
3.3 **Chronologically from new to old**

The pathway “chronologically from new to old” is (as the pathway “chronologically from old to new”) is describing the structure of the learning pathway, which the learner can make through the structured and assembled Content Containers. It is structured temporally as the pathway “chronologically from old to new” but the learner proceeds in the other way, which means: The pathway is starting at the Concept Container which is the last one in the sequence (the newest) and ending as the first (the oldest) Concept Container in the timeline is reached.

![Figure 6: Chronologically from new to old pathway](image)

3.4 **Hierarchically top down**

The pathway “hierarchically top down” is describing the structure of the learning pathway, which the learner can make through the hierarchically structured and assembled Content Containers.

The pathway starts at the top Content Container (C1) of the hierarchy (which is addressed by Reasoning, because other Concept Containers are marked with the relationship “hasParent” or “hasChild” but not above C1. After that, the next step to continue within the pathway is to move to the subordinate level of Concept Containers. These Concept Containers are all marked with the relation “hasChild” from C1. The pathway continues to further subordinate levels until the lowest level is reached. Then the pathway proceeds to all further Concept Containers on the same level which is pictured in figure 7 as “has Sibling” relationship. This relationship is not actually mapped in the technical Ontology (in the OWL File). However, it is the outcome of the Reasoning in the technical OWL, as e.g. one Concept Container has two relations marked with the relation “hasChild”. This means, two Concept Containers (e.g. in figure 7: C2 and C3 are both marked with the relation “hasChild” of C1) (for more detail, see Technical Summary in chapter 6). Next, all further concept containers one level above the lowest level are addressed. After this, the pathway continues to the next level and so on, until all Concept Containers have been accessed.
In the example above the sequence generated by INTUITEML will be: C1 C2 C6 C4 C5 C3 C7 C8.
3.5 Hierarchically bottom up

The pathway “hierarchically bottom up” can be described similar to the pathway “hierarchically top down”. The difference compared to the pathway “hierarchically bottom up” is, that the start is at the bottom level of the hierarchy and the end is at the top level Content Container.

Figure 8: Hierarchically bottom up

In the example the sequence generated by INTUITEL will be: C6 C4 C5 C2 C7 C8 C3 C1
4 Micro Learning Pathways

The Micro Learning Pathways are on the level of the Knowledge Objects in one Concept Container. The Micro Learning Pathways describe how the learner might proceed within one Concept Container. Thus the Pedagogical Ontology (PO) allows the definition of different sequences of Knowledge Objects in respect to their individual Knowledge Type and Media Type.

Within one Concept Container, there can be more than one Knowledge Object (KO). If there is more than one Knowledge Object, they are assembled and structured by Micro Learning Pathways.

Micro Learning Pathways are expressed by Media Types and Knowledge Types. The possible sequences between Media Types and between Knowledge Types are expressed by relationship types. The expression of the pathways by relationships allows authors to design the pathways flexibly. Thus it will be possible for authors to omit certain Knowledge and Media Types or to add Knowledge and Media Types from other pathways.

In INTUITEL there are four Micro Learning Pathways provided. Two learning pathways are on the level of Knowledge Types and two on the level of Media Types:

Knowledge Type Pathways:
1) Multi Stage Approach (Relation type: MultiStage)
2) Inquiry-Based Learning Approach (Relation type: InquiryBased)

Media Type Pathways (only applied for Learning Objects with the same Knowledge Type):
1) Abstracting (relation type: abstracting)
2) Concretising (relation type: concretising)

For the Media Types only one relationship is needed, since concretising is the same sequence as abstracting in reverse order.

4.1 Knowledge Type Pathways

4.1.1 Multi-stage Learning Pathway

4.1.1.1 Orientation

This pathway was chosen because the theory of multi-stage in learning pathways has a long history. Also known as “cognitive – associative – autonomous” or cognitive
apprenticeship, it can be said, that the multi-stage theory is based on the ancient Greek philosopher Aristotle, who structured the learning process in the phases of (1) sensuality and percipience, (2) wit and thinking, and (3) ambition and desire. Fitts and Posner (1967) used “cognitive – associative – autonomous” in their theory of learning phases. As the learner moves through the phases, he is willing to learn a new skill (Fitts, Posner 1967 cited after Anderson 1983).

In the first phase called “cognitive” stage, the learner is trying to figure out, what exactly needs to be done and is developing a declarative understanding. That means, the learner is confronted with the topic. The second phase is the associative stage, in which the learner needs to associate in relation to his understandings in this field within exercises and assignments. In the third phase the learner is able to solve problems on an expert level, provided that the learner went through the first two stages.

This learning pathway is the most often used learning pathway in German-speaking countries and also known as “Frontalunterricht”. It can be considered as a behaviouristic approach that is typically for a tradition where the principles of thinking are considered as an important background.

In chapter 4.1.1.2 three stories as examples for Multi-Stage Learning Pathway are give to have an idea of the structure of the Learning Pathway. Chapter 4.1.1.3 describes the main elements of the Multi-Stage Learning Pathway. Chapter 4.1.2.5 shows the learning phase and activities and lists the corresponding knowledge types.

4.1.1.2 Scenarios

The following scenarios are intended to illustrate the multi stage learning pathway.

1) Learning a new skill in sports – coaching

Imagine you are in physical education class in secondary school. Today the teacher wants to teach the shot-put motor skill. (1) Therefore she is telling you about the history of shot-put, that it was a play invented more than two thousand years ago. She shows the class the ball and explains a few facts about the shot-put discipline [KT: Orientation]. (2) After this introduction she takes the ball, and while she slowly and precisely demonstrates the movement, she describes the movement at the same time [KT: Explanation]. After that, she asks the students to try the movement but they are not yet ready to try it on their own. The teacher is showing the movement over and over again, so that every student can learn the skill [KT: Guided Simulation]. In order to practice the movement carefully, the teacher gives feedback and helps every single student [KT: Feedback by human tutor]. After practicing the movement, the teacher tells the students to stand in a row. One after another they must shot-put the ball. The student, who throws the ball the furthest, will win [KT: Assignment].

2) **Learning the formulas of conic section – teacher centred teaching**

Imagine you are a student in the secondary school. The maths teacher enters the room, welcomes everybody and starts with the lesson. She gives an introduction and tells the class what should be learned during this lesson [KT: Orientation], which is about conic section. First of all, she explains what conic sections are. A few pictures are shown, such as diagonally sliced salami stack. After that, she gives a short overview about the history of conic sections as well as their main characteristics [KT: Explanation]. (NOTE: At this point, the orientation and explanation, that is the first step in the multi-stage-learning pathway, are finished.) After the orientation and explanation, the teacher demonstrates an example on the black board. Step by step she explains what should be done, which formulas have to be used and how the problem is solved. The students copy what the teacher writes on the board into their notebooks. [KT: Good-practice example]. After this mainly receptive phase, the teacher asks the students to look in their maths book on page 321 to read the second example. Everybody reads the exercise. Then the teacher reads the text of the exercise out loud and starts to explain first step in order to solve it. Every student is following her instructions step by step, but also calculating on their own and making suggestions as to how to solve the problem [KT: Step-by-step example]. After the teacher and all students solved the exercise the teacher asks, if there are any questions or irritations. If there are no questions, the teacher gives more exercises for homework [KT: Assignment]. In the next maths lesson, the teacher asks, if everyone has completed the homework. She explains every calculation and goes on to the next topic.

3) **Story 3 – Learning how to configure a convector heater**

Imagine you are 17 and in a traineeship to become a plumber. Your supervisor is teaching you how to fix a convector heater. Therefore she is explaining to you in detail, how the convector heater is constructed and the safety aspects [KT:Orientation]. However, in order to learn how to fix it, she is taking you out to customers to demonstrate in practice how to mend a broken convector heater [KT:Explanation]. She analyses what the problem is with the convector, step by step, and at every step, she explains, what she is doing and what must be done next [KT: Simulation]. By watching the supervisor repairing the convector heater the student gets an idea of how the convector heater works and what to do, when it needs to be repaired. After 5 more customers, where the supervisor explains again and again, while repairing the heater step by step, the student is ready to repair one on their own. In the process, the supervisor will watch every step carefully and give you feedback or tips, as to what to do [KT:Guided Simulation]. If the student succeeds in repairing a convector heater, they are allowed to repair one on their own [KT:Assignment].

4.1.1.3 **Pathway Description**

<table>
<thead>
<tr>
<th>Model for educational pathways for multi-stage learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Pathway structure is based on.</strong></td>
</tr>
<tr>
<td><strong>2. Pedagogical</strong></td>
</tr>
</tbody>
</table>
## Background

Aristotle's learning phases (see chapter 4.1.1.1 Orientation). Moreover, it is a common way of teaching in school classes in most German speaking areas, which practise teacher-centred education. In the English-speaking areas, this form of teaching is relevant in teaching new skills in sports education and motor skill education. The cognitive-associative-autonomous learning pathway respective multi-stage learning pathway follows the three stages. The guideline can provide help and/or feedback for the learner, to “select a form of learning appropriate for learning goals and learning tasks” (Hoppe, Verdejo, Kay 2003).

## 3. Generic Learning Objectives

The students should:
- Understand the topic
- Consider relationship among knowledge
- (Re) Construct knowledge structure
- Add the new knowledge to existing schemata
- Practice new schemata
(Hoppe, Verdejo, Kay 2003).

## 4. Learning Stages & Activities

<table>
<thead>
<tr>
<th>Stage 1: Cognitive Stage</th>
<th>INTUITEL recommends Orientation and Explanation according to the topic.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2: Associative Stage</td>
<td>INTUITEL recommends an example, which is guided or simulated. The learner follows the steps, in order to solve future problems and examples in this topic on his own.</td>
</tr>
<tr>
<td>Stage 3: Autonomous Stage</td>
<td>INTUITEL recommends exercises and tasks to the student, to solve them on his own.</td>
</tr>
</tbody>
</table>

## 5. Type of structuring

<table>
<thead>
<tr>
<th>Simulated multi-stage-learning pathway (Simulated MSL)</th>
<th>In the simulated multi-stage learning pathway, after the orientation is given, the further steps are based on simulation. The learner is guided by the simulation through the Knowledge Objects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good-practice multi-stage-learning pathway (good-practice MSL)</td>
<td>In a good-practice multi-stage learning pathway is given after the orientation, the further steps are based on a step-by-step exercise in form of a good practice example. Therefore they must follow the example in order to solve the assignment during the last stage.</td>
</tr>
</tbody>
</table>

Table 3: Pathway Description for Multi-Stage Learning Pathway

The three stages in the process of a Multi-Stage Learning Pathway are there to develop skills (cognitive, associative and autonomous) and are described as follows: The cognitive stage is the phase of learning, where the target/goal of learning is to arouse interest and desire, and to adjust the goal to suit the learner's understandable and desire-able topic. To reflect the own learning process, this stage could be supported by an assignment and/or feedback from the LMS side. The associative stage is here to
adjust the cognitive skill of the goal within the practice, using examples and simply doing. From the LMS side this stage can be supported by an assignment and/or feedback. The autonomous stage is the stage where the skill is performed on an expert level (Hoppe, Verdejo, Kay 2003). During this stage the learner themselves should be able to decide whether they need more examples in order to learn the material.

4.1.1.4 Knowledge Types (KT) for a learning pathway based on multi-stage theory
Depending on the meta-data, learner model and other parameters, this pathway model diversifies in many ways. In INTUITEL there are two different versions of the Multi-Stage Learning Pathway (MSL) described (simulated MSL and good-practice MSL).

Knowledge Types for Simulated MSL Pathway:
This version of the multi-stage-learning pathway is based on the three stages (cognitive, associative and autonomous stage) and on simulation.
To express this pathway in INTUITEL the relation type “MultiStage” (the relation type in the technical ontology is described in chapter 5) and the following knowledge types will be used:
Table 4: Knowledge Types for Simulated MSL

<table>
<thead>
<tr>
<th>Learning Phase (LP)</th>
<th>Learning Activity (LA)</th>
<th>Knowledge Type (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1: Cognitive Stage</td>
<td>INTUITEL recommends learner orientation according to the topic</td>
<td>Receptive: Orientation (this could be: Facts, History, News, Log, Overview, Knowledge Map or Abstract)</td>
</tr>
<tr>
<td></td>
<td>INTUITEL recommends an explanation of the topic according to the relevance</td>
<td>Receptive: Explanation</td>
</tr>
<tr>
<td>Stage 2: Associative Stage</td>
<td>INTUITEL: Additional knowledge will be understandable by the simulation. In the simulation the learner follows in a receptive way.</td>
<td>Receptive: Explanation: Simulation</td>
</tr>
<tr>
<td></td>
<td>INTUITEL: The simulation is here for the learner in order to guide him through an example step by step. Learner gives answers in interactive simulation.</td>
<td>Interactive: Explanation : Guided Simulation</td>
</tr>
<tr>
<td>Stage 3: Autonomous Stage</td>
<td>INTUITEL recommends an example for the learner to solve on his own.</td>
<td>Interactive: Assignment : Simulation</td>
</tr>
<tr>
<td></td>
<td>Student gives answers.</td>
<td></td>
</tr>
</tbody>
</table>
Diagram of “Simulated MSL”:

<table>
<thead>
<tr>
<th>Learning Phases</th>
<th>Learning Activities</th>
<th>Knowledge Types (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1: Cognitive</td>
<td>INTUITEL: Gives learner orientation according to the topic.</td>
<td>Receptive - Orientation</td>
</tr>
<tr>
<td>Stage 2: Associative</td>
<td>INTUITEL recommends learner an explanation of the topic.</td>
<td>Receptive - Explanation</td>
</tr>
<tr>
<td>Stage 3: Autonomous</td>
<td>INTUITEL: Additional knowledge will be understandable by the simulation. In the simulation the learner follows in a receptive way.</td>
<td>Receptive – Explanation - Simulation</td>
</tr>
<tr>
<td></td>
<td>INTUITEL: The simulation is here for the learner in order to guide him through an example step by step.</td>
<td>Receptive – Explanation - Guided Simulation</td>
</tr>
<tr>
<td></td>
<td>Learner gives answers in interactive simulation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INTUITEL recommends an example for the learner to solve on his own.</td>
<td>Interactive – Assignment - Simulation</td>
</tr>
<tr>
<td></td>
<td>Learner hands in answers.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Diagram of Simulated MSL
Knowledge Types for MSL pathway – “good-practice MSL”:

The focus on this type of the Multi-Stage Learning Pathway is, that in the associative stage, the learner follows the example in an interactive way by making personal notes concerning the step-by-step example in order to solve the assignment.

<table>
<thead>
<tr>
<th>Learning Phase (LP)</th>
<th>Learning Activity (LA)</th>
<th>Knowledge Type (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1: Cognitive</td>
<td>INTUITEL recommends learner orientation according to the topic</td>
<td>Receptive: Orientation (this could be: Facts, History, News, Log, Overview, Knowledge Map or Abstract)</td>
</tr>
<tr>
<td></td>
<td>INTUITEL recommends an explanation of the topic according to the relevance</td>
<td>Receptive: Explanation</td>
</tr>
<tr>
<td>Stage 2: Associative</td>
<td>INTUITEL: Additional knowledge will be understandable by the example.</td>
<td>Interactive: Explanation: Good Practice: Step by Step</td>
</tr>
<tr>
<td></td>
<td>Student follows in an interactive way because he is urged to write down the steps on his own.</td>
<td>Interactive: Assignment: Hand-In</td>
</tr>
<tr>
<td>Stage 3: Autonomous</td>
<td>INTUITEL recommends an assignment to student to make alone.</td>
<td>Interactive: Assignment: Hand-In</td>
</tr>
</tbody>
</table>

Table 5: Knowledge Types for "Good practice" MSL
Diagram of “good-practice” MSL Pathway:

- **Stage 1: Cognitive Stage**
  - INTUITEL: Gives learner orientation according to the topic.
  - INTUITEL recommends learner an explanation of the topic.
  - Knowledge Types (KT): Receptive - Orientation, Receptive - Explanation

- **Stage 2: Associative Stage**
  - INTUITEL: Additional knowledge will be understandable by the example.
  - Learner follows in a interactive way because he is urged to write down the steps on his own.
  - Knowledge Types (KT): Interactive – Explanation – Good Practice – Step by Step, Interactive – Assignment – Hand in

- **Stage 3: Autonomous Stage**
  - INTUITEL recommends an assignment for the learner to make alone.
  - Learner hands in answers.
  - Knowledge Types (KT): Interactive – Assignment – Hand in

Figure 10: Diagram of “good-practice” MSL
4.1.2 Inquiry-based Learning

4.1.2.1 Orientation

In 2006 the OECD drew a general profile of student engagement in science. The profile showed that a personally held value of science, the students’ belief that they can succeed in science and the students’ enjoyment in solving science problems is not well developed. Conclusively, it was pointed out that “on average across OECD countries, 25% of students reported that they expected to be in a science-related career at the age of 30” (PISA 2006). Looking at the needs of science-related industries, there is a shortage of scientific personal across a wide range of business sectors. The OECD “Science, Technology and Industry Outlook 2000” points to the lack of scientific and highly skilled personnel. The “results suggest that policy related to science and technology personnel is a high priority throughout the OECD area” (OECD 2000).

Against this background, Michael Rocard and his research group was assigned by the European Commission to suggest solutions in regards to the gap between the general profile of student engagement in science and the shortage of scientific personnel in science, technology and industry. The Rocard report “Science Education Now: A Renewed Pedagogy for the Future of Europe” was published in 2007 and stated that “a reversal of school science-teaching pedagogy from mainly deductive to inquiry-based methods provides the means to increase interest in science. Inquiry-based science education (IBSE) has proved its efficacy at both primary and secondary levels in increasing children’s and students’ interest and attainment levels while at the same time stimulating teacher motivation” (Rocard 2007).

This learning pathway is most often used in English speaking countries and is typically for a conceptualisation of knowledge based on empirical evidence.

Inquiry-based science education (IBSE) is described as a deductive approach and is based on the idea that science learning should be authentic to science practice, an idea advocated by Dewey (1964a, 1964b). This approach allows students to observe, experiment and construct their own knowledge. “In inquiry learning, students are required to engage in more intensive self-regulative efforts than in traditional teacher-directed classroom situations” (Veermans, Lallimo & Hakkarainen 2005). “Participation in inquiry methods can provide students with the opportunity to achieve three interrelated learning objectives: the development of general inquiry abilities, the acquisition of specific investigation skills, and the understanding of science concepts and principles” (Edelson 1999). By definition, inquiry is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments (Linn, Davis & Bell 2004).
Looking at the Rocard Report and the widely progressed results in regards to students’ benefits from inquiry-based learning, it is without a doubt that inquiry based learning is a top claim within European Union institutions and officials for a good reason. Therefore, we have integrated IBL into INTUITEL. In chapter 4.1.2.2 one can find scenarios as examples for IBL. Chapter 4.1.2.3 describes the core aspects of IBL pathways and chapter 4.1.2.4 show learning sequences of open, semi-structured and structured IBL pathway. Chapter 4.1.2.5 shows the learning phase and activities and lists the corresponding knowledge types.

4.1.2.2 Scenarios

1) Imagine a class is making its way to a local stream. Some of the students used to swim in the stream but now they say it smells funny. The students became curious. The teacher motivates them to think of questions in regards to the stream. One of the students, her name is Tibika, asks: “Is it still harmless to swim in the stream?”. All the students want to know the answer and so they plan to test the water quality. They organise a range of tests to assess the situation and to decide what they can do about it. The teacher helps them decide what tests to do and how to analyse the results. She supports them by keeping track of what they are doing and gives hints, if necessary. Tobias says, “She always makes sure we choose a few things to do well and shows us how to do them properly”. Tibika says, “I want to go to the council and tell them all about what we find out because they need to know that this is happening and we need to work out how to fix it”. Tibika’s last action corresponds with the final activity in Inquiry-Based Learning pathway: Presenting evidence.

2) Another class is sitting in the computer laboratory of a residential school on the borders of Germany, Switzerland and Austria. In this school the majority of students are coming from different towns and cities of these countries. The topic is German grammar. Most of the students are pretty reluctant to engage in this topic. The teacher is a little bit frustrated, so he forms groups that are made up of students from different countries and engages them in talking about grammatical differences within the German language. One student asks: “How can we find out in which regions different grammatical forms are used?” Teacher suggests using the internet. The student groups start to look at local blogs and newspapers, social networks and local homepages and collect and count specific grammatical forms. The teacher guides the process and oversees what the students are doing. Finally the students put all the data together and present an interesting map of regional grammatical differences.

4.1.2.3 Pathway Description

<table>
<thead>
<tr>
<th>Model for educational pathways for inquiry-based learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pathway structure is based on ... Inquiry-based Learning</td>
</tr>
<tr>
<td>2. Pedagogical Background From a pedagogical perspective, Inquiry-based Learning is often contrasted with more traditional</td>
</tr>
</tbody>
</table>
Model for educational pathways for inquiry-based learning

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
</table>
|   | expository methods and reflects the constructivist model of learning, often referred to as active learning, so strongly held among science educators today. According to constructivist models, learning is the result of on-going changes in our mental frameworks as we attempt to make meaning out of our experiences (Osborne et al, 2003).
In classrooms where students are encouraged to make meaning, they are generally involved in "developing and restructuring [their] knowledge schemes through experiences with phenomena, through exploratory talk and teacher intervention" (Newton et al, 1999).
However, we use inquiry-based learning in a more specific manner, referring to a specific teaching model: an iterative process of (1) question eliciting activities, (2) active investigation by students, (3) creation, these are (4) discussed during early stages of the process, leading to (5) reflection about knowledge and the learning process, which in turn leads to new and refined questions (1) and the process goes on for another cycle.
Students are likely to begin to understand the natural world if they work directly with natural phenomena, using their senses to observe and using instruments to extend the power of their senses. Moreover, students must have access to PCs that are connected to the Internet. |
|   | The students should:  
- develop abilities necessary to undertake scientific inquiry  
- develop understandings about scientific inquiry  
- identify questions and concepts that guide scientific investigations  
- design and conduct scientific investigations  
- use technology and mathematics to improve investigations and communications  
- formulate and revise scientific explanations and models using logic and evidence  
- recognise and analyse alternative explanations |

3. Generic Learning Objectives
## Model for educational pathways for inquiry-based learning

<table>
<thead>
<tr>
<th>4. Learning Phases &amp; Activities</th>
<th>and models - communicate and defend their scientific arguments</th>
</tr>
</thead>
</table>
| **Phase 1: Question Eliciting Activities** | **Exhibit curiosity**  
INTUITEL tries to attract the students’ attention by presenting/showing to them appropriate material. **Define questions from current knowledge**  
Students are engaged by scientifically oriented questions imposed by INTUITEL (structured pathway) or suggest questions themselves (open pathway). |
| **Phase 2: Active Investigation** | **Propose preliminary explanations or hypotheses**  
Students propose some possible explanations in answer to the questions that emerged from the previous activity. **Plan and conduct simple investigation**  
Students give priority to evidence, which allows them to develop explanations that address scientifically oriented questions. |
| **Phase 3: Creation** | **Gather evidence from observation**  
Students formulate and evaluate explanations from evidence to address scientifically oriented questions. |
| **Phase 4: Discussion** | **Explanation based on evidence**  
INTUITEL recommends the possible explanation for the specific research topic. **Consider other explanations**  
Students evaluate its explanations in light of alternative explanations, particularly those reflecting scientific understanding. |
| **Phase 5: Reflection** | **Communicate explanation**  
Students produce a report with its findings, and presents and justifies its proposed explanations. |

### 5. Type of structuring

**Structured Pathway**  
In a structured pathway all possible questions, explanations, possible investigations, scientific methods to be implemented, learning content for observations, further evidence to be obtained and
### Model for educational pathways for inquiry-based learning

<table>
<thead>
<tr>
<th>Pathway Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-Structured Pathway</td>
<td>In a semi-structured pathway possible questions, explanations, possible investigations, scientific methods to be implemented, learning content for observations, further evidence to be obtained and possible results are pre-defined and available to the learner, but the learner can self-sufficiently suggest his/her own questions, explanations, possible investigations, scientific methods to be implemented, learning content for observations, further evidence to be obtained and possible results. The learners can choose whether to pick from the proposed questions to be explored and choose from proposed methods and evidence that is provided or create their own questions, methods and evidence.</td>
</tr>
<tr>
<td>Open Pathway</td>
<td>In an open pathway very little content is predefined. The learner is asked to create questions, explanations, possible investigations, scientific methods to be implemented, learning content for observations, further evidence to be obtained and possible results. The learner has no opportunity to choose from pre-defined questions, methods and evidence.</td>
</tr>
</tbody>
</table>

Table 6: Model for IBL Pathway

**4.1.2.4 Learning Pathway Model**

The Learning Activity Model provides the progression of learning activities for inquiry-based learning and outlines the connectivity of teaching phases and learning activities.
Learning Phases | Learning Activities of different pathway types
---|---
Open | INTUITEL exhibits curiosity for a domain or a concept
Semi-Structured | INTUITEL exhibits curiosity for a domain or a concept
Structured | INTUITEL offers different scientific questions

**Phase 1: Question Eliciting Activities**
- INTUITEL exhibits curiosity for a domain or a concept
- INTUITEL recommends input on “How to Formulate Scientific Questions”
- Student formulates a scientific question
- Student chooses one scientific question

**Phase 2: Active Investigation and Planning**
- Student proposes preliminary explanations or hypothesis
- Tutor gives feedback to the student
- INTUITEL recommends input on how to plan and conduct simple investigations
- Student plans and contacts investigation
- INTUITEL offers different simple investigations
- Student chooses and contacts one investigation

**Phase 3: Creation and active Observation**
- Student gathers evidence from observation
- Tutor gives feedback on how to structure and interpret the evidence
- INTUITEL provides good practice on how to structure and interpret the evidence
Figure 11: Flowchart for Learning Phases and Activities of different IBL Pathway Types
4.1.2.5 Knowledge Types for Inquiry-based Learning

To express this pathway in INTUITEL the relation type “InquiryBased” (the relation type in the technical ontology is described in chapter 5) and the following knowledge types for learning activities (LA) of inquiry-based learning (IBL) pathways are suitable:

4.1.2.5.1 Knowledge Types for an open IBL Pathway

<table>
<thead>
<tr>
<th>Learning Phase</th>
<th>Learning Activity (LA)</th>
<th>Knowledge Type (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: Question Eliciting Activities</td>
<td>Exhibits Curiosity the current concept</td>
<td>Receptive: pique curiosity and/or Interactive: pique curiosity and/or Cooperation: pique curiosity</td>
</tr>
<tr>
<td></td>
<td>Students formulate Questions</td>
<td>Interactive: Assignment: Hand-in: Formulating Questions</td>
</tr>
<tr>
<td></td>
<td>Human Tutor gives Feedback</td>
<td>Cooperation: Planned Cooperation: HumanFeedbackOnQuestions</td>
</tr>
<tr>
<td>Phase 2: Planning and Active Investigation</td>
<td>Student proposes preliminary explanations or hypothesis</td>
<td>Interactive: Assignment: Hand-in: propose hypothesis</td>
</tr>
<tr>
<td></td>
<td>Human Tutor gives Feedback</td>
<td>Cooperation: Planned Cooperation: HumanFeedbackOnHypothesis</td>
</tr>
<tr>
<td></td>
<td>How to plan and conducts simple investigations</td>
<td>Receptive: Action: PrincipleStrategy: Plan investigation</td>
</tr>
<tr>
<td></td>
<td>Student Plans And Conducts Investigation</td>
<td>Interactive: Assignment: Hand-in: Plan Investigation or Interactive: Assignment: Simulation</td>
</tr>
<tr>
<td></td>
<td>Human Tutor gives Feedback</td>
<td>Cooperation: Planned Cooperation: HumanFeedbackOnPlanInvestigation</td>
</tr>
<tr>
<td>Phase 3: Creation and Active Observation</td>
<td>Student gathers evidence from observation</td>
<td>Interactive: Assignment: Hand-in: Gather Evidence</td>
</tr>
<tr>
<td></td>
<td>Human Tutor gives Feedback</td>
<td>Cooperation: Planned Cooperation: HumanFeedbackOnEvidence</td>
</tr>
<tr>
<td>Phase 4: Discussion</td>
<td>Student provides explanation based on evidence</td>
<td>Interactive: Assignment: Hand-in: Provide Explanation</td>
</tr>
<tr>
<td></td>
<td>Human Tutor gives Feedback</td>
<td>Cooperation: Planned Cooperation:</td>
</tr>
</tbody>
</table>
Table 7: Description of open IBL Pathway

<table>
<thead>
<tr>
<th>Learning Phase</th>
<th>Learning Activity (LA)</th>
<th>Knowledge Type (KT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: Question Eliciting Activities</td>
<td>Exhibits Curiosity</td>
<td>Receptive: pique curiosity and/or Interactive: pique curiosity and/or Cooperation: pique curiosity</td>
</tr>
<tr>
<td></td>
<td>INTUITEL possible scientific questions</td>
<td>Receptive: Orientation: Question</td>
</tr>
<tr>
<td></td>
<td>Students chooses a question that guides the online lesson</td>
<td>Interactive: Assignment: Single Choice: Chose Question</td>
</tr>
<tr>
<td>Phase 2: Planning of Active Investigation</td>
<td>Student proposes preliminary explanations or hypothesis</td>
<td>Interactive: Assignment: Hand-in: propose hypothesis</td>
</tr>
<tr>
<td></td>
<td>Example of preliminary explanations or hypothesis</td>
<td>Receptive: Explanation: Example: Hypothesis</td>
</tr>
<tr>
<td></td>
<td>Propose possible scientific methods to engage the chosen question</td>
<td>Receptive: Orientation: Methods</td>
</tr>
<tr>
<td></td>
<td>Student chooses a Method</td>
<td>Interactive: Assignment: Single Choice: Choose Method</td>
</tr>
<tr>
<td>Phase 3: Creation and Active Observation</td>
<td>Student Conducts Investigation and Gathers Evidence from Observation</td>
<td>Interactive: Assignment: Hand-In: Plan Investigation OR Interactive: Assignment: Simulation</td>
</tr>
<tr>
<td></td>
<td>Example of evidence from the chosen method.</td>
<td>Receptive: Explanation: Example: Investigation</td>
</tr>
<tr>
<td>Phase 4:</td>
<td>Student provides explanation</td>
<td>Interactive: Assignment: Hand-in:</td>
</tr>
</tbody>
</table>
Table 8: Description of structured IBL Pathway

<table>
<thead>
<tr>
<th>Discussion</th>
<th>based on evidence</th>
<th>Provide Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example of explanations from the chosen question</td>
<td>Receptive: Explanation: Example: Explanation</td>
<td></td>
</tr>
<tr>
<td>Example of a different explanation from another method</td>
<td>Receptive: Explanation: Example: Further Explanation</td>
<td></td>
</tr>
</tbody>
</table>

Phase 5: Communication and Reflection

| | Student prepares presentation and communicates results | Interactive: Assignment: Hand-in: Present Evidence |
| | Example of presentation and possible communication of the results | Receptive: Explanation: Example: Present Evidence |
| | Student reflects on the differences between its own method, investigation, evidence and presentation and the examples given from INTUITEL | Interactive: Assignment: Hand-in: Reflect on Evidence |

4.2 Media Type Learning Pathway

The Media Type Learning Pathways are based on the theory of science as suggested by Charles Sanders Peirce. Peirce made a difference between icon index and symbol. While a picture of a tree is an iconic (concrete) sign for a real tree, the word “tree” is a symbolic (abstract) representation of a tree.

Media Type Pathways are applied only if there are Learning Objects with the same Knowledge Type and different Media Types available within one Concept Container (e.g.: orientation/text, orientation/video). If there are Learning Objects with different Knowledge Types and different Media Types available in one Concept Container (e.g. orientation/video, explanation/text) the Knowledge Type pathway will be applied.

4.2.1 Presentation Media Type Learning Pathway

4.2.1.1 Abstracting

Abstracting describes the learning pathway that INTUITEL follows to set up a sequence of Media Types from concrete to abstract. The Abstracting Pathways’ relationyhip type in the technical ontology is described in chapter 5.
In figure 12 the first Media Type within the Presentation Media Types in this pathway is “Video” (MT5). This Media Type is more concrete than Media Type “Photo” (MT4). That is why the relationship between these two Media Types “is more abstract than”. To read figure 11 correctly that means: Media Type “Photo” (MT4) is more abstract than Media Type “Video” (MT5). Continuing in the pathway, a more abstract Media Type than “Photo” (MT4) is “Audio” (MT3). “Table” (MT2) is a more abstract Media Type than “Audio” (MT3). Since there is no abstracter Media Type, and since this is the last Media Type within the Presentation Media Types, “Text” (MT1) is more abstract than “Table” (MT2). Within the pathway that means, that Media Type “Text” (MT1) is the most abstract Presentation Media Type.

Figure 12: Abstracting Pathway

4.2.1.2 Concretise

Concretise describes the Learning Pathway that INTUITEL follows to provide a sequence of different Media Types from abstract to concrete. It is defined as the reverse pathway “Abstracting”.

In figure 13 the first Media Type within the Presentation Media Types in this pathway is “Text” (MT1). This Media Type is more abstract than Media Type “Table” (MT2). That is why the relation between these two Media Types is named “is more concrete than”. To read figure 12 correctly that means: Media Type “Table” (MT2) is more concrete than Media Type “Text” (MT1). Continuing along the pathway, a more concrete Media Type than “Table” (MT2) is “Audio” (MT3). Furthermore, a more concrete Media Type than “Audio” (MT3) is “Photo” (MT4). Since there is no more concrete Media Type, and since this is the last Media Type, “Video” (MT5) is more concrete than “Photo” (MT4). Within the pathway that means, that Media Type “Video” is the most concrete Presentation Media Type.

The Concretise Pathway relationship type in the technical ontology is described in chapter 5.
Figure 13: Concretise Pathway
5的技术摘要

在下列章节中，将给出所有关系在本体中的概要。所有用于描述的学习路径（模拟多阶段学习路径、"优秀实践"多阶段学习路径、开放式探究学习路径、结构化探究学习路径）都描述了。此外，媒体类型和知识类型被用于媒体类型路径中，并与描述了。因此，知识类型和媒体类型在INTUITEL中被定义为他们的教育功能，这些功能在第4章中被描述。

在附录A中，所有知识类型和媒体类型被概述，并且每一种类型被简短描述。

5.1关系

在本体中的关系被如下描述了：

<table>
<thead>
<tr>
<th>Relation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macro Learning Pathways</strong></td>
<td></td>
</tr>
<tr>
<td>isBefore (between two CCs)</td>
<td>Connects two Concept Containers and marks the subject as the entity which occurred temporally before the object.</td>
</tr>
<tr>
<td>isAfter (between two CCs)</td>
<td>Connects two Concept Containers and marks the subject as the entity which occurred temporally after the object.</td>
</tr>
<tr>
<td>hasParent (between two CCs)</td>
<td>Connects two Concept Containers and marks the subject as the entity which occurred hierarchically below the object.</td>
</tr>
<tr>
<td>hasChild (between two CCs)</td>
<td>Connects two Concept Containers and marks the subject as the entity which occurred hierarchically above the object.</td>
</tr>
<tr>
<td><strong>Micro Learning Pathways</strong></td>
<td></td>
</tr>
<tr>
<td>isBeforeStructuredInquiryBased (between two KOs)</td>
<td>Connects two Knowledge Objects and marks the subject as the entity which occurred didactically before the object within the Structured Inquiry Based Learning Pathway.</td>
</tr>
<tr>
<td>isAfterStructuredInquiryBased</td>
<td>Connects two Knowledge Objects and marks the subject as the entity which occurred didactically after the object within the Structured Inquiry Based Learning Pathway.</td>
</tr>
</tbody>
</table>

---

6 http://www.w3.org/TR/xpath/
### Relation between CCs and KOs

<table>
<thead>
<tr>
<th>Relation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>containsConceptContainer</td>
<td>Connects a Knowledge Domain and a Concept Container.</td>
</tr>
<tr>
<td>containsKnowledgeObject</td>
<td>Connects a Concept Container and a Knowledge Object.</td>
</tr>
</tbody>
</table>

### Media Type Pathways

<table>
<thead>
<tr>
<th>Relation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>isMoreAbstractThan</td>
<td>Connects two Media Types and marks one subject as the entity which occurred to be more abstract then the object.</td>
</tr>
<tr>
<td>isMoreConcreteThan</td>
<td>Connects two Media Types and marks one subject as the entity which occurred to be more concrete then the object.</td>
</tr>
</tbody>
</table>
isContainedByConceptContainer (between Knowledge Object and Concept Container)
Is defined as reverse property of “containsConceptContainer” within the ontology and connects a Knowledge Object with a Concept Container.

isContainedByKnowledgeDomain (between Concept Container and Knowledge Domain)
Is defined as reverse property of “containsKnowledgeObject” within the ontology and connects a Concept Container and a Knowledge Domain

Table 9: Overview of relations in the Ontology

5.2 Knowledge Types
The following Knowledge Types are used in the Learning Pathways (Simulated Multi Stage Learning Pathway, “Good-Practice” Multi Stage Learning Pathway, Open Inquiry Based Learning Pathway, Structured Inquiry Based Learning Pathway). This listing should be an overview of the Knowledge Types, which are used in the Learning Pathways. The full vocabulary of all Knowledge Types can be found in Appendix A.

- Multistage Learning Pathway
  o Simulated Multistage Learning Pathway
    ▪ Receptive Knowledge Type
      • Orientation
    ▪ Receptive Knowledge Type
      • Explanation
    ▪ Receptive Knowledge Type
      • Explanation
      o Simulation
    ▪ Interactive Knowledge Type
      • Explanation: Guided Simulation
    ▪ Interactive Knowledge Type Assignment
      • Simulation
  o Good Practice Multistage Learning Pathway
    ▪ Receptive Knowledge Type
      • Orientation
    ▪ Receptive Knowledge Type
      • Explanation
    ▪ Interactive Knowledge Type
      • Explanation
      o Good Practice
        ▪ Step by Step
    ▪ Interactive Knowledge Type
      • Assignment: Hand-In
- Inquiry-based Learning Pathway
Open IBL Pathway

- Receptive/Interactive/Cooperation
  - Pique Curiosity
  - Receptive Knowledge Type
    - Action
      - Principle/Strategy
        - Formulating Questions
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
        - Formulating Questions
- Cooperation Knowledge Type
  - Planned Cooperation
    - Human Feedback On Questions
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
        - Propose Hypothesis
- Cooperation Knowledge Type
  - Planned Cooperation
    - Human Feedback on hypothesis
- Receptive Knowledge Type
  - Action
    - Principle/Strategy
      - Plan investigation
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
      - Plan investigation
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
      - Gather Evidence
- Cooperation Knowledge Type
  - Planned Cooperation
    - Human Feedback on Evidence
- Interactive Knowledge Type
  - Assignment
    - Hand-In
    - Provide Explanation
- Cooperation Knowledge Type
- Planned Cooperation
  - Human Feedback on Explanation
- Receptive Knowledge Type
  - Action
    - Principle/Strategy
      - Present Evidence
- Interactive Knowledge Type
  - Assignment
    - Hand-In
      - Present Evidence
- Cooperation Knowledge Type
  - Planned Cooperation
    - Human Feedback on presentation
- Structured IBL Pathway
  - Receptive/Interactive/Cooperation
    - Pique Curiosity
  - Receptive Knowledge Type
    - Orientation: Question
  - Interactive Knowledge Type
    - Assignment
      - Single Choice
        - Chose Question
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
        - Propose Hypothesis
  - Receptive Knowledge Type
    - Explanation
      - Example
        - Hypothesis
  - Receptive Knowledge Type
    - Orientation
      - Methods
  - Interactive Knowledge Type
    - Assignment
      - Single Choice
        - Choose Method
  - Interactive Knowledge Type
    - Assignment
      - Hand-In
        - Plan Investigation
5.3 Media Types

Media Types are used in Abstracting and Concretising the Presentation Media Pathway. This listing should be an overview of the Media Types which are used in the Pathways. The full vocabulary of all Media Types can be found in Appendix A.

- Text
- Table
- Audio
- Video
- Photo
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Appendix A - Possible Extension of the Knowledge Type and Media Type Vocabulary

The vocabulary for Knowledge Types, Media Types and Relationships is considered as a heuristic concept. The concept might be shortened or extended according to the requirements of authors and learners. The following chapters for possible extensions are derived from “Web-Didaktik” by Norbert Meder and “E-Learning konzipieren und gestalten mit der Web-Didaktik” by Christian Swertz and translated into English. These suggestions will most probably not be applied in INTUITEL and are listed here for information purpose only.

Knowledge Type Vocabulary

Knowledge Types are due to didactical requirements. However, this structure of knowledge must be always seen as preliminary, because it can only be structured according to the goals of the knowledge type structure. Knowledge types are structured by means of the function within the learning process. This is the didactical goal of the organisation of knowledge for the learning process. Functions within the learning process are presentation (receptive knowledge), trial (interactive knowledge) and communication (cooperative knowledge).

Receptive Knowledge Type

Receptive Knowledge Types (e.g. Orientation, Explanation) contain media for presentation. Within the media, the knowledge is displayed but without changing the presentation because of the media. The presentation is static. The learner is receiving the knowledge but is not active beyond that.

- Pique curiosity: Should pique the students’ curiosity in regards to a certain field of interest and/or subject matter as well as should motivate the students’ drive for further questions.
- Orientation:
  Orientation Knowledge gives orientation in one field. Knowledge is orientation knowledge, if it is naming and relating the field with other knowledge and if it can be connected to previous knowledge of the learner. This knowledge is represented in terms of: Facts, History, News, Log, Overview, Knowledge Map, Abstract, and Scenario.
  - Facts are representations of objects and occasions in terms of data and information. Data and information can be time data, numerical values, etc. Facts are describing an issue in a short concentrated form.
  - Histories are representations of a process and correlation of all events, which are linked to space and time.
  - News
  - Logs: Are timely bits of feedback about activities and performance as well as problems in regards to a specific issue/problem/question
  - Overviews are representing a sequence of single steps of an event as well as the structure of an issue along general lines.
Knowledge Maps are schematic representations of connections between terms and definitions by declaring the concept surrounding field and the functional connection, which is given between one term and the terms within this context.

Abstracts are short presentations of material, which is described in more detail somewhere else.

Scenario is a chronologically, regionally, institutionally, personally and role-typically complex of occasions, which is reality, or designed towards the image of reality.
- A story is a scenario in form of a narrative.
- Virtual World is a scenario, in which complex issues are represented in a three-dimensional form. In Virtual Worlds, the learner has the possibility of manipulation.

Methods: Gives an overview and orientations about methods which are applicable within a certain field and/or subject matter

Questions: Gives an overview and orientations about possible questions which are applicable within a certain field and/or subject matter

- **Explanation**
  Knowledge is an explanation, if it gives reasons for representations or claims. An explanatory statement is necessary, because representations can always be different. An explanatory statement for a representation names the method, which is used by the representation. Explanatory Statements are arguments, examples, descriptions, interviews, comments, definitions, exemplifications or ideas/tips.

- An argument is a linguistic act within discursive constructions.
- An example is a case of a general circumstance (instantiation). It is used to demonstrate an issue or a term.
  - Hypothesis: This good practice example demonstrates scientific hypothesis in regards to an specific issue
  - Investigation: This good practice example demonstrates a plan of investigation in regards to an specific issue
  - Explanation: This good practice example demonstrates an explanation in regards to an specific issue
  - Present Evidence: This good practice example demonstrates evidence in regards to an specific issue
  - Further explanation: This good practice example demonstrates further explanation in regards to an specific issue
  - A description is a linguistic representation of a topic. The description determines an issue without stating the possible causes or gives a correlation. Descriptions give information about properties of an object or relations between objects.
  - An interview gives the reason for a representation within verbal expression of an authority triggered by questions.
  - Comments are interpretations of documents, which were produced by someone else.
- Definition is the purpose of the “Definiendum” by specifying the “Definiendum” throughout fundamental attributes (“Definiens”).
- Exemplifications are comments, which are made on own documents.
- Idea/Tip
- Simulation

- Action
  - Instructions are a description of work steps to accomplish a certain activity. Thereby, possible errors and their correction are also considered. There are administrative instructions, operation instructions and social standards.
  - Checklists are reminder lists in order that critical parameters are not missed. It is useful to make checklists in order to control which items are reviewed and which are not.
  - Laws are legal rules.
  - Rules are standards and prescriptions in form of “if, then” descriptions. Processes need rules to make them classified, manageable and acceptable for participants.
  - Principle/Strategy is a constitutional or general sentence, which is the basis for the construction of concrete sentences and rules. If the sentence contains choices of action where the action is orientated by the action on the situation, it is called a strategy.
    - Formulate Questions: This strategy shows the students how to formulate scientific questions.
    - Plan investigation: This strategy shows the students how to plan investigation.
    - Present evidence: This strategy shows the students how to present evidence.

- Sources
  Sources answer the question as to find information. If a person is in possession of sources, he/she can answer the question “where to find knowledge?”. Therefore, the sources must be published and known. References on sources are made through indications of sources. Sources differ in types. Important types of sources are link lists, list of literature and downloads (which can be addresses or archives).
  - A link list is a set of URLs. They may contain references to download.
  - A list of literature contains references to representations of knowledge in form of media. These could be monographs, journal articles, movies, sound recordings, software and other representation possibilities in media.
  - An address gives the postal address of an institution or a person. It can also contain the address of an archive within the address list.
    - An archive is an adjustment to gather, preserve and oversee systematically judicial, political and cultural documents, images and sound property. These properties can be certificates, files, letters, maps, plans, newspapers, etc. The best-known form of an archive is a library.
**Interactive Knowledge Type:**

Learning items with Interactive Knowledge contain knowledge, whose presentation is influenced by the activity of the learner. The activity of the learner within the learning process is very useful if knowledge can be learned in an explorative way and if this knowledge can be proved in action, or the knowledge is tested within an assignment.

- **Assignment:**
  - Detecting Assignments: The learner must explore complex issues, legalities, or errors in the present material. These complex issues, legalities, or errors are hidden and will be visible depending on the activities of the learner.
  - Mapping Assignments are built up to connect elements of a quantity to another quantity.
  - Arranging Assignments are made to arrange a given quantity of elements in a special kind of way.
  - Sequencing Assignments are made to serialise a given quantity of elements.
    - Build Sentence – Assignments are made for the learner to construct a sentence out of given parts of a sentence respectively single words.
    - Technical construction - Assignments are made for the learner to construct a complex gadget or item out of given technical building elements.
  - In Short answer – Assignments the learner must give answers in form of text or numbers, which will be evaluated automatically. If the answer can only be evaluated by a teacher and not by the computer, this assignment is called a “long-text-assignment”.
  - Ticking – Assignments are tasks where the learner has to choose one or more pre-formulated answers. There are three types of ticking-assignments: single choice, multiple choice, true/false-question.
    - Single choice assignments are questions, where a few answers or choices are given but only one is the right answer or one has to be chosen. The learner has to identify the right answer or a preferred choice.
      - Choose question
      - Choose method
    - Multiple-choice assignments are questions, where a few answers, which are given, are right and a few are wrong. The learner has to identify the right answers (and/or the wrong answers).
    - True-False assignments are made out of a true or a false statement. The learner has to identify, if the statement is true or false.
    - Within Discrimination-Assignments the learner has to detect differences between items. These assignments are very important, because the process of making a difference is here to develop a sophisticated cognition.
Fill in the blank: Assignments are made using a given text with one or more gaps/blanks within the text, which should be filled-in by the learner.

Within Spelling-Assignments the learner has to spell a given word. (Fill-in-the-blank and Spelling-Assignments are often used to study languages.)

Simulation Assignments are Simulations, where the learner has to follow the simulation, and within passing tasks continuing the simulation.

- Articulation
- Educational game
- Hand-In

  - Propose hypothesis: Is an assignment in which students are asked to propose their own hypothesis based on their knowledge of a certain field.
  - Formulate questions: Is an assignment in which students are asked to formulate their own questions based on their knowledge of a certain field.
  - Plan investigation: Is an assignment in which students are asked to plan their own investigation based on their knowledge and questions of a certain field.
  - Gather evidence: Is an assignment in which students are asked to gather evidence based on their knowledge, questions and plan of investigation.
  - Provide explanation: Is an assignment in which students are asked to provide their own explanation based on their knowledge, questions, plan of investigation and evidence.
  - Present evidence: Is an assignment in which students are asked to present evidence based on their knowledge, questions, plan of investigation, evidence and explanation
  - Reflect on evidence: Is an assignment in which students are asked to reflect on the presented evidence

- Pique curiosity: Should pique the students’ curiosity in regards to a certain field of interest and/or subject matter as well as should motivate the students’ drive for further questions.

- Explanation
  - An explanation in the form of a “Guided Simulation” is guiding the learner through a simulated explanation of a topic. A “Guided Simulation” is interactive, because the learner must follow the explanation in an active way (at least: click on a button, if the LMS is requesting this.)
  - A Good practice is an interactive type of knowledge, if the learner can influence the description of the example.
    - “Step by step” means, that within a good practice example, every step in for example solving a problem is explained by the example. The focus is on the steps and the structure of every step which should be made.

- Repeating
- Drill and practice promotes the acquisition of knowledge or skill through repetitive practice
- Delayed repeat

**Interactive Video:**
- Simulations: are useful, if an issue within the learning process is not able to be proven directly, because the observation of the object is too complicated, too expensive or too dangerous. In that case simulations are there to replace the original.
- Investigation

- MiniCBT (CBT = Computer Based Training) are short linear or branched interactive sequences, where different media forms (model, graphic, sound, speech, etc.) can be combined. Linear sequences with question-answer-examples are often used, where the learner is guided through sequences of small information elements. After the presentation of the small information elements, a test can be made, which detects, whether the presented information was learnt. If the test was negative, the same information elements should be shown (This approach follows the rules of the educational concept of programmed instruction.). CBT-Sequences should be shortened into elements of 3 – 5 minutes. The traditional sequential arrangement is: presentation -> instruction -> execution -> feedback.

**Cooperative Knowledge Types:**
A didactical cooperation is a communication between humans, in which they work together on a certain topic in order to understand each other above expertise. Cooperative knowledge items are essential in order to react on unscheduled required knowledge. Cooperative Knowledge can be procured planned or spontaneous.

**Planned Cooperation:**
Planned Cooperation is a didactical cooperation, which occur at particular points within the learning process.
- **Talk**
- **Role-play** is a form of cooperation with multiple persons in small groups. Before the cooperation starts, the roles and their actors are planned.
- **Conferences** (learning conferences) is a cooperation between multiple persons (more than 100), e.g. a lecture.
- **Counselling** is a form of cooperation between two persons.
- **A workgroup** is a form of cooperation between two or more persons in small groups (e.g. group discussions).
- **Feedback by human tutor** is described as an individual feedback from a teacher/tutor on an assignment, which was carried out by the learner.

**Spontaneous Cooperation:**
Spontaneous Cooperation is a form of didactical cooperation, where the date for
the cooperation can never be planned.
  o The cooperation between the learner and the teacher at a particular point in time is called “question to counsellor”, if it contains some content from the course.
  o A spontaneous cooperation is called “counselling on learning method”, if the process of transfer of knowledge is the topic of the cooperation.
  o A spontaneous cooperation on a various point of time between two or more learners is called “community communication”.

- Pique curiosity: Should pique the students’ curiosity in regards to a certain field of interest and/or subject matter as well as should motivate the students’ drive for further questions.

**Media Type Vocabulary**

**Communication:**
Communication Media Types are described as tools for people to communicate directly with each other. In this list are only media types, which are used, online within networked computer technology.

- **Synchronous:**
  - A Chat is based on written language.
  - An audio-conference is based on vocal language.
  - A videoconference is based on audio-visual communication.
  - Shared Applications provide a shared usage of an area of the screen.

- **Asynchronous:**
  - E-Mail is a type of communication based on written form between single persons. The messages are delivered in electronic form analogue to the traditional mailing services.
  - News group is a type of communication based on written form within a group, where the messages must be treated individually.
  - Mailing list is a type of communication based on written form within a group. The messages are delivered in electronic form and each member of the group will get the message, which was sent to the mailing list.

- **Blog**
- **Combined:**
  - Social Media

**Presentation:**

- Animations contain pictures and graphics, which are ordered linearly.
- Audio:
  - Sounds are noticed at all time for a human.
  - Music is a sequence of notes and noises, which are ordered by intent.
  - Speech is vocal language for a public audience.
• Photos are pictographic presentations of an item. In learning processes pictures are used for visualisation and demonstration.

• Drawing

• Tables contain numbers or keywords ordered according to a certain scheme. The key features are mostly placed in the columns, the cases, items or events are placed in rows.

• Text is a written sequence of propositions. There are different types of text, e.g. short story, press release, report, advertising text, etc.

• Videos are visual and audio-visual presentations, which are played with a sequence of pictures of at least 16 pictures per second. Videos are useful to demonstrate processes and happenings.

**Interaction**

• Form is a type of media, where structured documents with blank spaces have to be filled out for further processing via a LMS. These blank spaces, which have to be filled out by the learner can be checkboxes, radio buttons, lists, etc.

• Interactive Videos are videos, where the user can at least interact via stop-and-go-functions with the computer. It would get better if the learner could also influence the plot of the interactive video.
The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement N° 318496.
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