Educational Scenarios with E-portfolios

A Taxonomy of Application Patterns

Peter Baumgartner
peter.baumgartner@donau-uni.ac.at

Danube University Krems, Austria

Abstract: Dealing with electronic portfolios is complex and demanding. Especially the implementation at the educational institution and the proper integration in daily demands of ongoing teaching and learning processes poses many challenges for students and teachers alike. This paper proposes an educational taxonomy as methodological approach to overcome some of these difficulties. Theoretical foundations, construction and use of this general framework will be presented, its application for e-portfolios discussed. The goal is to develop a pattern language for electronic portfolios in higher education.

1 The Need of an Educational Taxonomy

There is a lot of skepticism in some areas of the humanities and especially by educational practitioners in using formalized tools and methodological frameworks. It is suspected that these aids cannot cover the extremely broad range of educational activities and it is therefore assumed that these tools constrain innovative educational practice. They could be helpful for novices but experienced teachers will be hindered in their creativity for a learner oriented instructional design.

Most of the current didactical guidelines which are used in teachers' education support this critical claim. An example are the templates still used in many training institutions to assist the lesson planning process of schoolteachers. These forms are too narrow in their use concerning time schedule and almost block teachers from developing a holistic outlook on the realizing their broader educational goals.

In contrast to these restraining templates we need a framework which may not only support but also generate creativity and educational variety. Such a systematic framework has to meet at least two characteristics in order to support diversity (see more in detail [6]):

1. **Innovation**: Didactical innovation is not constrained if (a) the taxonomy provides a sufficiently large repository of cases and (b) the classification system is well founded and transparent. A huge repository which clusters e-portfolio scenarios under systematic and theoretically sound premises nurtures didactical diversity for the following reasons: Inexperienced novices will not only discover many instances of what they are looking for, but the dazzling array of exemplars, cases, opportunities, strategies and scenarios they encounter will already be grouped and "tamed" into categories. They will therefore not be overwhelmed by complexity and

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#	Layers of Educational Actions	Levels of Educational Abstractions					
		Non-formalized Descrip-tions	Methods		Principles	Dimen-sions	Categories
			Patterns	Models			
		1	2a	2b	3	4	5
H	International Educational Systems						
G	National Educational Systems						
F	Educational Institutions						
E	Curricula						
D	Modules						
C	Educational Ensembles						
B	Educational Scenarios						
A	Educational Interactions						

Fig. 1. Taxonomy of Instructional Methods

be encouraged to experiment with as yet unknown situations. Experienced experts, on the other hand, will take the reduced complexity as a starting point for their inquiry. They will modify, amplify, add, and substitute where necessary. Taxonomies are tools that can be adapted and should not be considered holy, sacrosanct and inviolate shrines.

2. **Heuristic**: Serving as heuristic tool is a very important property of all classification systems. Special attention is drawn to all inconsistencies, as they are a challenge to the whole taxonomy and its underlying principles. Either these discrepancies disappear or the taxonomy itself will be discredited. On the other hand, finding solutions to the inherent problems of the taxonomy helps to improve it and demonstrates the usefulness of the constructed classification schema.

2 Taxonomy of Instructional Methods

2.1 Action Levels for E-Portfolio Learning Settings

Working in teacher education for nearly 30 years I have noticed the lack of such a reference system in many training sessions. Trying to overcome this problem for many years I have just finished developing a two dimensional taxonomy table (cf. Figure 1 on page 2) as a proposal to fill the mentioned gap. The formal idea of a taxonomy of two dimensions was inspired by “A Taxonomy for Learning, Teaching, and Assessing” [4] and my realization of the table dimensions as different layers of educational actions and different levels of descriptions was motivated by Karl-Heinz Flechsig, a late German Educational Scientist [11,12].

To understand the system of categorization I will present a series of definitions for a better understanding how to handle this taxonomy. For the purpose of this contribution I will focus at the description level {2a}, especially at the levels of scenarios and ensembles. (For a detailed discussion of the significance of different columns and rows of this two dimensional table see my German forthcoming book to be published in October 2011 [7].)

Definition 1. *A Scenario is defined as an educational setting in the time frame of several minutes to about one hour of learning time. It describes an educational arrangement designed or set up to provide a methodological educational unit. This action level creates didactical driven units under the aspects of time, space and social configuration.*

Note that the main reference point here is called "learning time" which is very different to physical time. It means "student workload" in EU parlance and is measured in ECTS (European Credit Transfer and Accumulation System) and functions as a standard for comparing the study attainment and performance of students of higher education.

Definition 2. *An Ensemble is defined as an educational setting in the time frame of about one hour to several hours of learning time. It describes the learning goals for a specific subject and the formation of different scenarios for reaching the specified learning target. This action layer creates thematic driven units under the aspects of scenario configurations.*

Comparing both definitions you will find a special relationship between them: The "higher" educational action layer contains the "lower" layer. The proposed taxonomy is an inclusive hierarchy, the "lower" layers are included in the "higher" ones.

The different educational action layers are defined by their learning time but they can also be grouped by their difference in scope.

Definition 3. *A scope of an educational action layer is defined by its range of influence, its extent of impact to the educational system. It is a yardstick of the action radius for educational design.*

In this paper I will concentrate on just the layers of {B} and {C} but for the usage and implementation of e-portfolios the higher action layers – in varying degree – are important too. Action level {A} (e.g. asking a question or uploading a file) is concerned with the instructional design at a micro level of seconds to minutes guided and covered by the theory of communicative action [13] and will be out of focus for this article as well.

2.2 Description Levels for E-Portfolio Learning Settings

The X-axis of the taxonomy table is divided into different levels of educational abstractions. I distinguish between six levels, whereas in Flechsig's conception exist only three levels of generalizations. Twice as many description levels are of practical importance because it reduces the cognitive distance between different levels.

Grasping the idea of description levels is more complicated than understanding action layers. In contrast to the Y-axis of action layers "lower" levels of descriptions are

not included into "higher" levels but they represent the *same* phenomenon with a more abstract description than the "lower" level. Due to this difficulty of handling descriptions I will specify here not only the – for this paper – most interesting pattern row {2a} but also outline briefly the other description levels as well.

Level {5} is formed by a very general educational model only consisting of categories of the main classes of objects involved in the educational process and their relationships. These very general educational models are called categorial models. A very famous but in the meanwhile outdated categorial model is the "educational triangle", consisting just of the classes "teacher" (which forms the top of the triangle), "pupil" and "content". My proposed model is much more complex and consists of seven interrelated categories: In the center there is the category of "learner", surrounded by the concepts "learning assistant" (in contrast to the traditional "teacher"), "learning requirement", "learning material", "teaching/learning tool", "educational learning environment" and "ambiance" as the environment which is given and cannot be designed educationally.

Level {4} is formed by a so called dimensional analysis which investigates the characteristics of the educational categories. There are eight dimensions directly inferred from the seven educational categories which are very crucial for every learning process. These educational dimensions I call educational modes. They are as follows: Number of learners, role of learner, role of learning assistant, type of learning requirement, structure of material, role of teaching/learning tool, role of educational learning environment and type of reference to the non-educational environment. But there are many other dimensions which are derived from the relationships between educational categories like type of learning action, cognitive process, knowledge type, competence level, learning style, type of feedback, degree of responsibility, degree of participation, degree of trust respectively reliance etc.

Level {3} is formed by a composition of the word "learning" which specifies an important aspect of the learning process like independent learning, holistic learning, enquiry-based learning, discovery learning etc. These educational principles are derived from educational dimensions. Each dimension consists of five ranked educational principles and is therefore a ranking scale including educational principles between to opposites. These opposites are not antagonistic but polar, meaning they can be differentiated. For instance: Between the two poles hot and chilly exist warm, lukewarm and cold. Similar with educational principles: The educational dimension "cognitive process", for example, is divided into learning by remembering, understanding, applying, analyzing / evaluating, and creating (cf. to the cognitive process notions [4]).

Level {2} is the central description format for educational methods. This abstraction level is subdivided into the Level {2b} and {2a}. The first one is the more abstract one and is formed by the traditional way of describing instructional methods. Here the essence and main characteristic of the method is explained as an abstract model in a context free way. In contrast the pattern format of Level {2a} is closer to the practice situation and therefore better suited for a context sensitive application. I will explain this important and relatively new description format more in detail in Section 3.2.

Level {1} is a very detailed practice description, mostly reported as a chronological history of occurrences. I does not contain generalized conclusions of the applied instructional methods and is therefore not very beneficial for educational purposes.

As a summary we can say that the X-axis starts with very concrete descriptions lacking specified educational vocabulary and ends with very abstract notions lacking the necessary concreteness to guide teachers actions. The remaining parts of this paper will outline three steps towards a pattern language for working with e-portfolios in higher education which is sufficient precise for practical application but at the same time abstract enough to cover a broad range of contextual conditions and dependencies.

3 Three Steps Toward a Pattern Language for Electronic Portfolios

3.1 First Step: Inductive Development of Electronic Portfolio Categories

As a starting point for compiling a catalogue of patterns for working with e-portfolios we analyzed use cases at different Austrian universities. The system of basic categories and characteristics of e-portfolios was developed within a two-year project "The use of e-portfolios at (Austrian) universities" funded by the Austrian government [10]. In the course of this research work we thoroughly dissected literature to e-portfolios using qualitative text analysis, conducted interviews with implementation managers at higher eduction institutions and arranged several (web) site visits. Through analysis, monitoring, and comparing we formed the theoretical basis for an inductive pattern mining process.

The result of this first research step was threefold:

1. We categorized e-portfolio software which was available at that time (cf. Figure 3 on page 7 [15]). The methodological foundation for this product evaluation was published several years before and already successfully used with Learning Management Systems (LMS) and Content Management Systems (CMS) [8,9]. A case study of an implementation is reported by Himpsl-Gutermann [14].
2. We discovered three main types of e-portfolios: reflection, development, and presentation portfolios. Each of this three essential use cases can be subdivided by their ownership (personal or institutional e-portfolio, what we called Type A and Type B) and by their product or process orientation (producing artifacts or reflecting learning outcomes). In total we got with Figure 2 on page 6 a taxonomy of 12 ($3 \cdot 2 \cdot 2$) different e-portfolio types .
3. It turned out, that the most essential result was the categorization of the main activities applied during working with electronic portfolios. At first we believed that this was just an intermediate step to arrive at the mentioned twelve different types of electronic portfolios. But later on we noticed that these categorized verbs formed the basis for a formalized description format as outlined in the second step of the ongoing research process.

3.2 Second Step: Pattern Approach and Pattern Mining

In our funding contract with the Austrian ministry of Education and Science we had the obligation to report our findings as an internal working paper to the ministry but later on as a publication for the general public too. This book has to include a guideline for educational practitioners "using an innovative and handy form of representation".

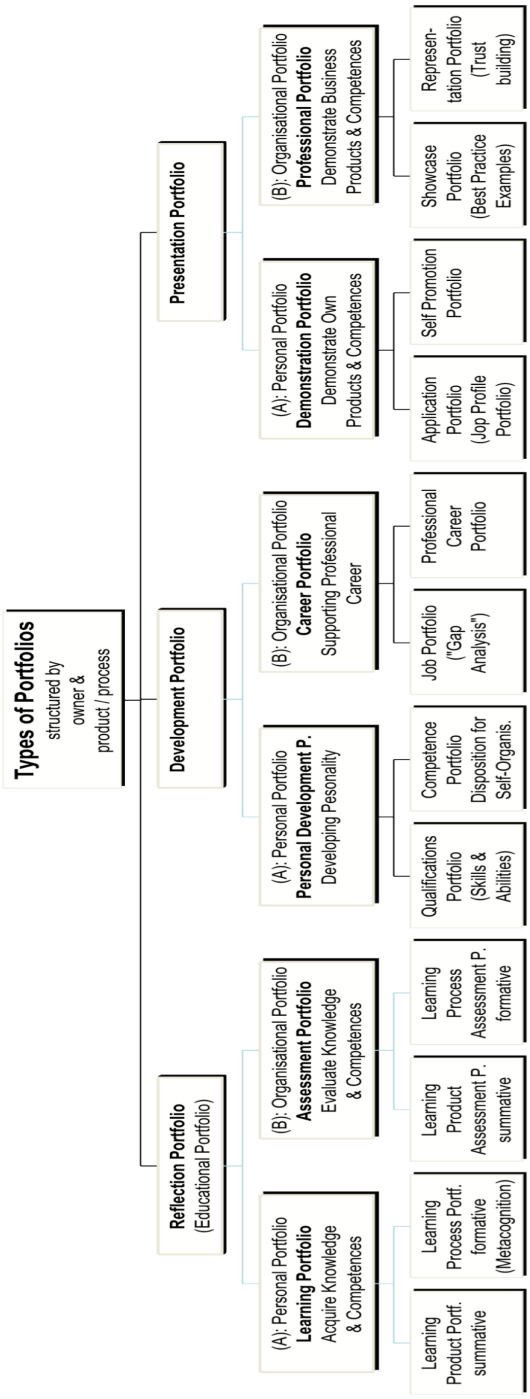

Fig. 2. Taxonomy of Electronic Portfolios

Evaluation of E-Portfolio Systems Overview (May 2008)		Effort for first time installation	Collecting Organizing Selecting	Reflecting, Testing, Verifying Planning	Representing Publishing	Administration	Usability
Product	Licence						
Drupal ED	open source	high	✓ ✓ ✓	✓	✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Elgg	open source	medium	✓ ✓ ✓	✓	✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Epsilen	commercial	low	✓	✓ ✓	✓	✓	✓
Exabis	open source	low	✓	✓	✓	✓ ✓ ✓	✓ ✓
Factline	commercial	medium	✓ ✓ ✓	✓	✓ ✓ ✓	✓	✓
Fronter	commercial	medium	✓ ✓ ✓	✓ ✓	✓	✓ ✓	✓
Mahara	open source	low	✓ ✓ ✓	✓ ✓	✓ ✓ ✓	✓ ✓	✓ ✓
Movable Type	open source	high	✓ ✓ ✓	✓	✓ ✓	✓ ✓ ✓	✓ ✓
PebblePad	commercial	low	✓ ✓ ✓	✓ ✓	✓ ✓ ✓	✓ ✓	✓ ✓
Sakai	open source	medium	✓ ✓	✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓
Taskstream	commercial	medium	✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓	✓ ✓
Wordpress	open source	medium	✓ ✓ ✓	✓	✓ ✓	✓ ✓	✓ ✓ ✓

Fig. 3. Evaluation of E-Portfolio Systems

Independently from this actual responsibility to find an innovative and generic form of representation I was introduced to the pattern approach of Christopher Alexander by colleagues of computer science several years ago when I was working as professor for educational technology at the German distance teaching university in Hagen. The architect and philosopher Christopher Alexander constructed a so called pattern language. It is meant as a description framework for building and planning houses and cities, which was distilled from his and his colleagues' building and planning efforts. This pattern approach – as it was called later on – emerged in the late 1970s and several years later researchers in different fields like software engineering, user interface design adopted it for their domain. In the late 1990s the work on pedagogical patterns started, mostly developed by computer science professionals involved in teaching programming language.

As I came across these first pedagogical patterns I was not convinced by them because I could not find educational innovation in it. At that time I looked for new didactical approaches in these patterns and did not understand that the innovation was not in the content or subject presented with this approach but in the description format. Pedagogical patterns capture like any other type of patterns the implicit knowledge of experts, in this case of educational experts. Experts develop through their long lasting practical experiences a kind of tacit knowledge which is very difficult to transmit by language [17].

Influenced and inspired by the discussion of patterns and pattern language in the pattern community I abandoned my critical view and reflected with Reinhard Bauer how the philosophical issues hidden in the works of Alexander [1,2] could be applied to pedagogy. Based on newer – more philosophical oriented – works of Alexander [3] we developed a pattern format for describing educational settings.

Definition 4. *"A pattern is, in short, at the same time a thing, which happens in the world, and the rule which tells us how to create that thing, and when we must create it. Each pattern is a relationship between a certain context, a certain system of forces which occurs repeatedly in that context, and a certain spatial configuration which allows these forces to resolve themselves" [2, p.247].*

Thus, the three key elements of a pattern are just "context" or "forces", the "problem" and a "solution" which has already proved of value. The natural dominance of spatial configurations for architecture is replaced by a similar importance of social configurations in education.

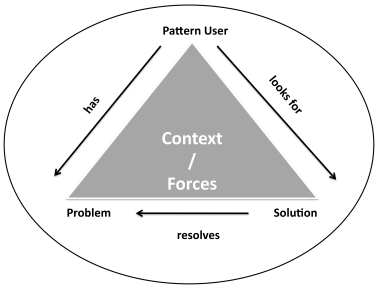

Fig. 4. Inner Structure of a Pattern

Alexander says: "To make a pattern explicit, we merely have to make the inner structure of the pattern clear" [2, 249] But to make the inner structure clear is in practice the most difficult task in pattern creation and has to be based on a thorough analyses of the forces which are involved in creating the situation and/or solution.

Forces can be understood as the intention of actors with the qualification that in a metaphorical sense artifacts can also be viewed as actors. This view is not new in social sciences as Bruno Latour for instance is talking of non-human actors in his groundbreaking book on a new paradigm in sociology [16]. In the Actor-Network-Theory (ANT) human intentions are inscribed into artifacts by humans so that we can say for instance that a door "invites" to enter or leave a room.

A decisive step for generating patterns for work with electronic portfolios was the categorization of activities as mentioned before. These activities can be regarded as forces in the Alexandrian sense and are the key in pattern mining not only for electronic portfolios but also for educational issues in general. We distinguished three types of activities which are important for the creation of an electronic portfolio:

1. **Backbone activities**: collecting, documenting, illustrating, elaborating and producing. These activities are -– regardless of the type of portfolio -– absolutely essential for any portfolio work. At first I discarded these categories as they were not sufficiently selective for generating different types of electronic portfolio. Later my co-worker Reinhard Bauer argued that these activities are the hidden backbone of the description formats for all educational scenarios and educational ensembles using electronic portfolios and have to be "revived" and incorporated again into our analysis of patterns.
2. **Main activities**: selecting, assessing, organizing, planning, presenting, networking, and reflecting. These seven activities are essential for discriminating different types of electronic portfolios.
3. **Other activities**: deciding, identifying, inspecting, approving, judging, giving feedback, appreciating, linking, and discussing. These verbs are subcategories supporting backbone and main activities alike.

3.3 Third Step: Identifying and Describing Generic Design Patterns

In the third and last step towards a pattern language for electronic portfolios we have identified 37 design patterns. The detailed description of these will be presented in a forthcoming book available at the end of this year. In the meanwhile the reader may read three examples to get an impression of the practical results of our research [5].

The pattern we came up with have generative character, i.e. the individual design patterns can be well combined with each other and used in various combinations. They also form the basic vocabulary of a constantly evolving pattern language for working with e-portfolios.

Compared to conventional didactical guidelines, the identified e-portfolio patterns support a wider variety of application scenarios. Just like the basic vocabulary of a natural language, which consists of different parts of speech (noun, verb, adjective, etc.) with specific functions in terms of possible combinations (sentence and text level), the collection we developed also describes e-portfolio patterns with different functions: e.g. patterns for the implementation of e-portfolios in courses or patterns for the creation and design of e-portfolios. Analogous to a generative grammar which enables a speaker to understand and to generate an infinite number of sentences, even though there are only a finite number of words available, the described design patterns enable to create an infinite number of e-portfolios.

The pattern language for working with e-portfolios represents the basic vocabulary in the form of different patterns that help lecturers and students to work on and with e-portfolios. For better orientation within the pattern language and for better locating individual patterns we have divided the catalogue of design patterns into five groups:

- Patterns for e-portfolios referring to the reflection, development, and presentation portfolio as the three main types of e-portfolios
- Patterns for the organization of e-portfolio work
- Patterns for individual learning
- Patterns for reflective learning, and
- Patterns for collaborative learning.

These five groups of overall patterns contain other (sub-) patterns. Depending on the particular role users of this pattern language play in the overall structure of the e-portfolio work, they can select those patterns which, according to their individual needs, are relevant in a specific phase of the e-portfolio work.

4 Conclusion

So far I have described exemplarily just two fields {B:2b} and {C:2b} of the taxonomy table as outlined in Figure 1 on page 2. But “Patterns can exist at all scales” [2, p.247]. This means that for every cell of the {2b} row exist patterns which are related to each other at the same action level but also to patterns at different levels. This means that our result of 37 patterns just form a small part of a more complete pattern language to be developed in the future.

But even if we would have such a huge and complex web of interrelated patterns we would cover just a tiny piece of guidance for educational practitioners as the domain of

electronic portfolios itself merely is a small part of the possible varieties of educational settings for effective learning processes. The presented taxonomy is therefore just a general generic framework and does not limit innovation and creation of new learning arrangements.

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