

# E-Portfolios for Integrated Reflection

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## Abstract

E-portfolios have been widely used in the education community. Currently, e-portfolios are viewed mostly as a tool of assessment and showcase, but less as a tool of active learning. This paper proposes an ontological model that specifies a generic organizational structure of e-portfolios in the integrated reflection context. An example of design artifact of ontology of e-portfolios is used to illustrate the concepts of the development and use of e-portfolios for active learning through reflection.

**Keywords:** E-portfolios, integrated reflection, learning object, ontology, design research.

## Introduction

Recently more and more students and teachers are using e-portfolio systems. There will be massive pieces of electronic portfolio artifacts stored in those systems. E-portfolios are supposed to serve three purposes: assessment, showcase, and learning (Greenberg, 2004). For assessment purposes, e-portfolios include rubrics-based documentations and feedback from teachers. For showcase purposes, e-portfolios present artifacts of accomplishments and lifelong career development. For learning purposes, e-portfolios can be useful for on-going reflection. The current commercial or open source e-portfolio systems have been successfully used for assessment and showcase, but have not been effectively applied to enhancing students' learning (Zhang, Olfman, & Rectham, 2007). This is mainly because generic e-portfolio systems are more or less learning domain (or subject) independent. On the other hand, useful learning portfolios must be learning domain specific. This challenge raises a significant research question: how e-portfolios can be used as a learning tool for students thinking. To make generic e-portfolio systems more useful for enhancing students' thinking, a layer of e-portfolio system must be developed to facilitate students' integrated reflection. In this study, reflection is higher-order thinking for a purpose such as learning what one has learned. Integrated reflection is active higher-order thinking process cross the boundaries between topics, courses, or even disciplines.

This paper proposes an ontological model that specifies a generic organizational structure of e-portfolios in the integrated reflection context. The ultimate objective of this study is to make contribution to information systems design science (Gregor 2006; Gregor & Jones 2007; Hevner, March, Park, & Ram, 2004; Walls, Widmeyer, & El Sawy, 1992) through the demonstration of an information system artifact for e-portfolio systems.

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## Related Work

### ***E-Portfolios***

A portfolio is a systematic and purposeful collection of work and achievement documentations (Drier, 1997). E-portfolios are highly personalized, customizable, Web-based files which document learning portfolios and demonstrate individual and collaborative learning process (McCowan, Harper, & Hauville, 2005). An e-portfolio system is a Web-based repository management system that stores students' learning documents (known under the name of artifacts) such as academic records, essays, project reports, assignments, assessments, and personal and professional development related contents. Students use e-portfolio systems to present artifacts, receive feedback from instructors and advisors, and communicate with each other.

There are many commercial, non-profit organizational, and open-source e-portfolio systems, such as Chalk & Wire (CW, 2009), KEEP toolkit (KEEP, 2009), foliotek (2009), TaskStream (2009), and Open-Source Portfolio (OSP) (OSP, 2005). While there are high variations of user interface design among these e-portfolio systems, the functionalities of current competitive e-portfolio systems are about the same and include artifacts editing and uploading, commenting and assessing on student work, communicating and sharing within groups, showcase generating, and administrative reporting.

E-portfolios are stored online and have great accessibility for the portfolio owners themselves, teachers, colleagues, and employers (Bruder 1993; Bushweller 1995; McCowan *et al.* 2005). E-portfolios are a mechanism for students and education institutions to improve and demonstrate their teaching/learning skills and to display competencies to the society (Lumsden, Garis, Reardon, Unger, & Arkin, 2001). E-portfolio systems enable administrations at all levels to survey and to conduct comprehensive assessment of teaching and learning accomplishments (Barrett 1994).

### ***E-Portfolio Artifacts are Learning Objects***

An e-portfolio artifact is a unit of digital resource that can be used to support learning, and thus is a learning object (Wiley & Edwards, 2002). Along with the increasing use of e-learning systems, learning objects become increasingly valuable and, at the same time, the management of learning objects repository becomes complicated (Cohen & Nycz, 2006; Collis & Strijker, 2003; Singh, Hawkins, & Whymark, 2007). There have been metadata standards for learning objects, such as those proposed by Dublin Core (DC, 2009), IEEE LTSC (IEEE LTSC, 2009), and IMS Guide (IMS, 2006), which is similar to library catalogue systems. However, to effectively use learning objects to support teaching and learning for a specific field, domain knowledge must be applied to manage the learning objects (Harman & Koohang, 2005; Koohang, 2004; Mustaro & Silveira, 2006). This has lead to approaches to Semantic Web applications that model the relationships between learning objects using formal ontologies (Sicilia & Lytras, 2005).

Ontology techniques have been applied to repositories of learning objects (Namuth, Fritz, King, & Boren, 2005; Smrz, 2004; Snae & Brueckner, 2007; Wang, 2008; Zouaq Nkambou, & Frasson, 2007). However, few research reports have discussed ontologies of e-portfolios for reflection and active thinking.

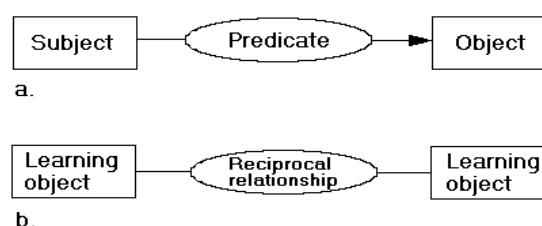
### ***Ontology Represents Structures of E-Portfolios***

Ontology is a science that studies explicit formal specifications of the terms in the domain and relations among them (Gruber, 1993). In the general philosophical term, an ontology is a specification of a conceptualization (Gruber, 1995). In the Semantic Web field, an ontology is typically

a network of semantically related objects for a specific domain. An ontology allows people to share common understanding of the subject domain.

According to Resource Description Framework (RDF) (W3C, 2009), a primitive ontology is a triple containing a subject, an object, and a predicate (relationship) (see Figure 1a). Its special form that represents the reciprocal relationship between two learning objects (dual subject and object) is shown in Figure 1b. A large ontology for an entire domain is a composition of a set of primitive ontologies. In this study, an ontology is a conceptual network of all related learning objects that shows the semantic relationships between the learning objects in the application domain.

Ontology is a powerful modeling approach; however, without a domain analysis for particular types of applications, the ontology approach remains a virtual philosophy, rather than a concrete technique for common understanding sharing (Devedzic, 2004). From the viewpoint of conceptual modeling theories, ontology is an object-oriented model for the application domain (Wang, 1999). To build ontologies based on the methodology progression, ontologies of e-portfolios must present the object-oriented vision. The task of a domain analysis is for the construction of an ontology is to actualize classes of e-portfolio objects and their semantic relationships, as illustrated in the next section of this paper.



**Figure 1: Primitive Ontology.**

Research (Perkins, Jay, & Tishman, 1993a, 1993b; Quillian 1968) has made connections between ontology and thinking that ontological expressions of domain specific knowledge and thinking processes can make significant contributions to teaching reflection. Although the real reflection activities in the human brain remain by and large an enigma, ontologies enable us to describe thinking routines (Ritchhart, 2002) for reflection process, and to make reflection visible as well as teachable.

## Ontological Categories of E-Portfolios Artifacts for Integrated Reflection

To make ontologies sharable in a domain, it is important to categorize objects in the domain (Noy & Hafner 1997). Categorizing e-portfolios artifacts can be helpful for the design of ontological structure of e-portfolio systems. The entire ontology of an e-portfolio system is usually large. To provide a large ontology visual and manageable to the user, the entire ontology must be partitioned. This is done through categorizing artifacts and developing the dynamic and inheritance relationships. A formalized generic category (or meta-learning-objects) of e-portfolios artifacts can help a community in developing and sharing its ontology, especially when the e-portfolio system is incorporated into a global learning system. However, in the broader literature, there is a lack of formal ontological description of e-portfolios artifacts. Next, we discuss generic e-portfolios artifacts categories through a domain analysis to identify and formalize fundamental types of artifacts and their relationships involved in integrated reflection.

### *Learning Subject*

A learning subject is a meta-artifact that defines a discipline. It can have sub-subjects. A learning subject structure is a type of generalization structure. A typical order of the hierarchy of learning subjects for an e-portfolio system is:

- College/School
- Program
- Course
- Topic.

A learning subject can have its attributes and descriptions. In the interdisciplinary context, a learning subject can inherit from multiple super-subjects. A topic is a primitive learning subject, and is associated with a learning objective directly.

### ***Learning Objective***

A learning objective is an artifact that describes a measurable learning outcome. Each learning subject retains its learning objectives. Bloom's taxonomy of education objectives (1956) is a framework that has been widely used in all disciplines. The original Bloom's framework includes six levels of learning: knowledge, comprehension, application, analysis, synthesis, and evaluation. Given the recent development in the knowledge management field, the term knowledge is no longer appropriate in this context. If knowledge and comprehension are merged into one level of learning, there are five levels of learning objectives as listed below.

- Understanding – know, define, identify, be aware of, etc.
- Application – apply, formulate, explain, etc.
- Analysis – analyze, organize, resolve, etc.
- Synthesis – design, plan, recommend, etc.
- Evaluation – justify, criticize, evaluate, etc.

### ***Rubric***

A rubric specifies the criteria and standards for assessment, and is used to measure whether students have achieved the learning objectives. A rubric is usually a table. The rows of table list the criteria for the students' work (e.g., assignment, project, essay, etc.), and the columns of table list the assessment standards (e.g., excellent, very good, good, poor, etc.). Teachers assess students' work against the rubrics to maintain the uniformity of assessment. Samples of various rubrics can be found in (RUBRIC, 2009).

### ***Assessment Instrument***

An assessment instrument is a tool or technique to measure whether students have achieved the learning objectives. For instance, a test that contains quiz questions and/or questions for short answers is an assessment instrument to evaluate whether students understand the topic. An essay assignment or a textbook case analysis report is an assessment instrument for assessing students' analysis competency. A technical assignment is an assessment instrument to evaluating students' problem solving ability. A list of project requirements can be an assessment instrument to evaluate whether students have reached the evaluation learning objective. A student self-evaluation questionnaire can be an assessment instrument for soliciting students' opinions on an instructional method.

### ***Student Work***

Artifacts of student work are the major component of e-portfolios. Typical student work artifacts are:

- a reading report;
- an essay or reflection report;
- a case analysis report;

- an assignment;
- a project report;
- an exhibit; and
- a test or examination.

In a broad view, less formal student's discussion notes in collaborative environment can also be artifacts of student work.

## ***Assessment Outcome***

An assessment outcome artifact is a documentation of learners' performance. At the elemental level, an assessment outcome artifact can be an individual learner's examination paper. At the collective level, a summary of assessment outcomes can be an artifact to measure the effectiveness of a course or program. In the educational literature the use of assessment outcomes to improve reflection is underreported. This is because traditional educational systems view the assessment outcome as the end of education, and do not store and utilize much assessment outcomes for iterative integrated reflection. Along with the proliferation of e-portfolio systems, massive assessment outcome artifacts are stored online. These artifacts provide valuable resources for teachers to teach integrated reflection as well as for students to learn integrated reflection.

## ***Reflection Dominant Model***

Reflection is a thinking process more than simple memorization and comprehension, and involves a variety of cognitive processes, such as summarization, identifying general principles, exploring various situations, reconciling options, monitoring progress, and so on. Although reflection emphasizes general thinking strategies and abilities across diverse situation, domain-specific knowledge guides sophisticated reflection (Ericsson & Smith, 1991).

Aram and Noble (1999) argue that the dominant models of learning and thinking are appropriate to the stable and predictable aspects of organizational life. To teach and learn integrated reflection, we need structured instruments or guidelines for reflection. Model is an important tool, if not the only one, that compels integrated reflection (Dunne & Martin, 2006). While the ultimate models of reflection in great managers' mind might not be available, models can provide guidelines for integrated reflection. We refer models for teaching and learning integrated reflection to as reflection dominant models. For instance, the decision making model (Simon, 1976) taught in business can help students develop reflection dispositions of decision making. Students can apply this dominant model to any managerial decisions in all business subjects and think about the decision making processes as well as the important roles of data and information in decision making.

## ***Reflection Query***

A reflection dominant model can have questions, or reflection queries, for students to instigate reflection. A reflection query can be very general. For instance, the decision making dominant model can have generic reflection queries such as: How is the decision making model related to the cases you analyzed in many courses? Why were the decisions made in the cases you analyzed successful or failed in the view of the decision making model? How do you interpret variation to the standard decision making model? etc. A reflection query can also be specific to instigate reflection based on individual student's work.

Clearly, reflection dominant models are general tools or instruments for teaching and learning integrated reflection, and reflection queries are specific instructions which highly depending upon the teacher's analysis on students' reflective thinking.

## Construction of an Ontological Structure of E-Portfolios for Reflection

An ontology of e-portfolios for reflection is a synthesis of these eight categories (learning subject, learning objective, rubric, student work, assessment instrument, assessment outcome, reflection dominant model, and reflection queries) of e-portfolios artifacts on the contingency of teaching and learning integrated reflection. The synthesis process is to formalize the relationships between the e-portfolios artifacts of these categories. The premise of ontology is that generic semantics commonly exist among the objects that could be used for general purposes of navigation and search in the domain. In our case, these semantic relationships are used for general purposes of teaching and learning integrated reflection. For instance, in terms of inheritance relationships, a top-level *Subject* "has\_a" low-level *Subject*. In terms of dynamic relationships, an *Objective* "uses" a *Rubric*. The generic dynamic semantic relationships between the e-portfolios learning objects are summarized in Figure 2. To focus more on integrated reflection, we choose the most relevant portion of the ontology, as shown by the shaded parts, for our case study of design of e-portfolios structure for integrated reflection.

## Designing E-Portfolios for Integrated Reflection: A Case Study

To learn more about ontological structure of e-portfolios for integrated reflection, a project was conducted to investigate the feasibility of design. We developed an ontological structure of e-portfolios using the model discussed in the previous section (see the shaded part of Figure 2), and then implemented the structure on Chalk & Wire ePortfolio2 (CW, 2009). Chalk & Wire ePortfolio2 is a pioneer e-portfolio system which has been widely used in Canada, the United State, and other countries.

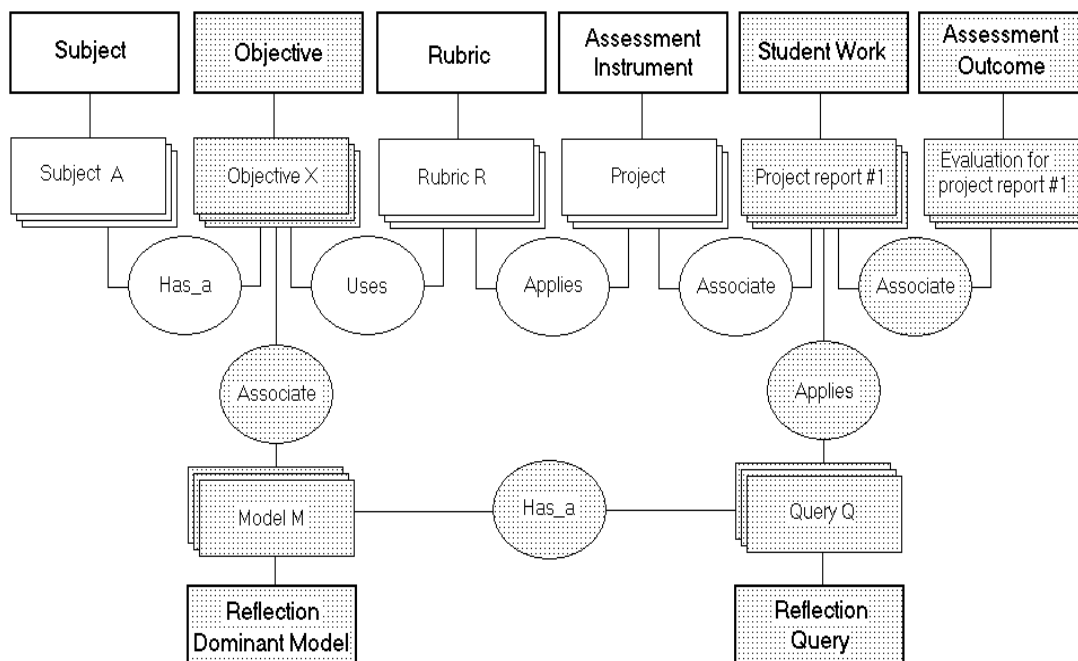
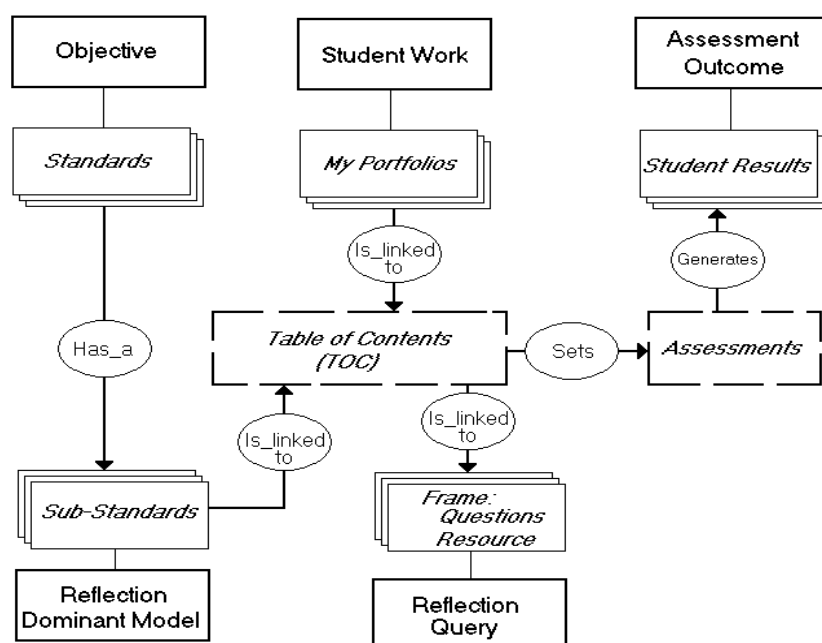


Figure 2: Ontology of E-Portfolios for Integrated Reflection.

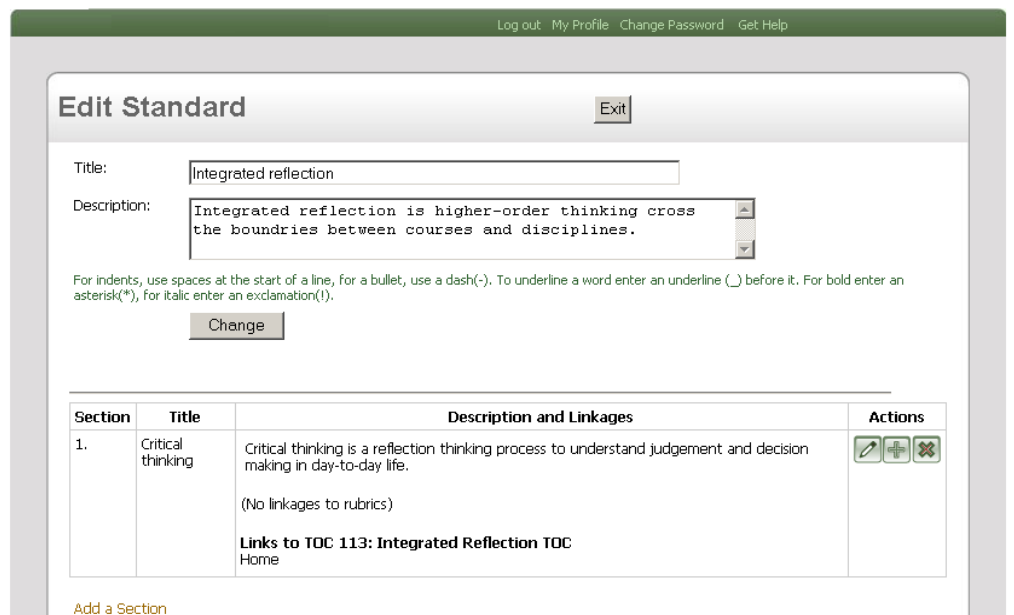


**Figure 3. Ontological Structure of ReThink on Chalk & Wire ePortfolios2 System.**

We used the Chalk & Wire ePortfolios2 platform to implement a prototype of an extension shell, called ReThink, for integrated reflection. Figure 3 shows the inter-relational structure of the ontology at the top level of ReThink. We borrowed the artifact types of Chalk & Wire ePortfolios2 (artifacts in *Italic* in Figure 3) for this shell. For instance, we used *Sub-Standards* of Chalk & Wire ePortfolios2 for reflection dominant models, *My Portfolios* for student work, etc. In addition, Chalk & Wire ePortfolio2 has *Table of Content (TOC)* and *Assessments*. These two special types of artifacts are able to connect and generate the generic types of e-portfolio artifacts discussed in the previous section, as shown in Figure 3. We used the functions in *TOC* and *Assessment* to implement the semantic relationships between the e-portfolios artifacts for integrated reflection. Note that the Chalk & Wire ePortfolio2 system must link a *TOC* to a *Rubric(s)*. Although Figure 3 does not include *Rubric* in order not to dilute our emphasis on integrated reflection, one needs to create a rubric for a *TOC* in ReThink.

As an example, we present the features of the support of reflection in the learning subject of business. This is merely to demonstrate the approach to teaching and learning integrated reflection through the use of e-portfolios discussed above, but not for discussion of the pedagogical design which is a topic independent of this study. Figure 4 shows the creating of reflection dominant models through *Sub-Standards* in ReThink. Figure 5 shows the creating of reflection queries through *Questions* in *Frame* of *TOC*. One can also create reflection queries in *Resource* in *Frame*. The example in Figure 6 shows that the student was creating an e-portfolio artifact for a reflection assignment which was linked to the *TOC*. He was able to view the reflection queries for the reflection assignment. Once the student completed his reflection e-portfolio artifact, the *TOC* set *Assessment* for the teacher to generate *Student Results* as an assessment outcome.

The following primary lessons have been learned from the design of this prototype of shell.



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Change

Section	Title	Description and Linkages	Actions
1.	Critical thinking	<p>Critical thinking is a reflection thinking process to understand judgement and decision making in day-to-day life.</p> <p>(No linkages to rubrics)</p> <p><b>Links to TOC 113: Integrated Reflection TOC Home</b></p>	  

[Add a Section](#)

**Figure 4: Creating Reflection Dominant Models through *Standards*.**

(1) On the learning side, e-portfolios provide a perfect environment for students to view their portfolios online to learn what they have learned, and think about the way they think. For learning, the major difference between e-portfolios and online course-based teaching systems is that e-portfolios shall be the source for the development of life-long learning ability cross the dimensions of time, courses, disciplines, and positions.

(2) On the teaching side, reflection dominant models and reflection queries are high-level information and codified knowledge of teaching reflection, and can be shared by the teaching community. This prototype has shown that e-portfolios can be an integrated teaching tool, which has not been widely implemented in the e-portfolios community.

(3) The ontology is a platform independent tool for system design. Individual e-portfolio system may have its own way to implement it, as demonstrated in our case study.

(4) Teaching and learning integrated reflection through e-portfolios is by no means at no cost. To connect an e-portfolio artifact to the ontology, one must define its relationships to other artifacts in accordance with the semantics defined by the ontology. The more relationships are defined, the better the e-portfolios are shared by the community.

To test a design of artifact like this prototype, rigorous independent experiments must be conducted to verify whether such an e-portfolio-based teaching tool is effective for integrated reflection. This case study has its limitation in that the ontological model and the prototype have not reached practical trials beyond the design experience. Clearly, while this study makes no claim to the validity of the proposed approach, it does offer an original idea of teaching and learning integrated reflection through the use of e-portfolios. This study has made its initial contribution to the accumulated weight of empirical evidence for establishing the validity of this approach.



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### Edit Frame in Page Layout Exit

Table of Contents: Integrated Reflection TOC

Section: Home

Heading:

Show: ☒ Include in portfolio

Question:

Description:

If you supply a heading, it will show when the student is entering the portfolio, and also in the portfolio itself, and the student will not be able to alter the heading. If you leave the heading blank, the student will be able to supply one, or to leave it blank.

If you check this box, the heading and any question you enter will appear in the portfolio itself. If you uncheck it, the heading will appear only to the student when editing the portfolio.

If you supply a question, it will show when the student is entering the portfolio, and also in the portfolio itself. If you leave the question blank, it will be omitted from the portfolio. If you uncheck the 'include in portfolio' checkbox, do not enter a question.

Any description you provide is visible only to the student while entering the portfolio. It does not show up in the portfolio itself.

For indents, use spaces at the start of a line, for a bullet, use a dash(-). To underline a word enter an underline ( \_ ) before it. For bold enter an asterisk(\*), for italic enter an exclamation(!).

Figure 5. Creating Reflection Queries in TOC Frame

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### Portfolio Edit Details Exit

Portfolio: Example Theme: Generic Theme 7 TOC: Integrated Reflection TOC Last Modified: 30 Nov 2008 10:36:56

**Home**

**Reflection Dominant Model: Decision Making Model**

What have you learned from business cases of success and failure in terms of decision making process?

**Page Information**

1 Related Standard(s)

1 Rubrics for Assessment(s)

Portfolio Preview Add Content Share Page Portfolio Preferences Submit Assessment

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Figure 6: Creating a Reflection E-Portfolio Artifact

## Conclusion

The competence of e-portfolios depends not only on the abundance of artifacts, but also the effectiveness of the use of e-portfolios for active learning. This paper recognizes a lack of applications of e-portfolios for integrated reflection beyond course-based teaching and assessment, and pro-

poses a framework of ontological structure of e-portfolios for integrated reflection. The ontological model is based on the premise that integrated reflection is teachable through e-portfolios. The ontological model places the focal points on reflection dominant models and reflection queries, which are normally missing in e-portfolio applications. It adds explicit relationships between the e-portfolio artifacts that would make integrated reflection more visible. An ontology can be a teacher's teaching tool for teaching integrated reflection, or student's learning tool for active thinking cross the curricula. Technically, this study has primarily focused on the semantic aspects of e-portfolios for integrated reflection, and has shown the approach of e-portfolios to e-learning.

As an example, we have implemented the ontological structure of e-portfolios through the use of Chalk & Wire ePortfolio2. Our preliminary case study has shown new challenges for all parties involved in the e-portfolio community. For educational institutions, there is an organizational need to develop ontologies that contain semantic information about integrated reflection in various domains. The ontologies should be maintainable to represent the currency of integrated reflection. For e-portfolio systems developers, new techniques and tools are imperative to develop comprehensive uses of e-portfolios beyond assessment and showcase. In our view, the ontological model proposed here can practically be used for e-portfolio systems development. For teachers, new skills of teaching integrated reflection are required. They must clearly understand ontological structure of teaching integrated reflection, and transform unstructured reflection activities to structured tasks based on their own ontological structure of integrated reflection. For students, applications of e-portfolios for integrated reflection will be a new challenge of e-learning. In the long run, e-portfolios will be indisputable effective tool for active learning.

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