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Scaffolding Knowledge Management in E-Portfolios

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Abstract: A key challenge in Higher Education is how to develop learning and assessment opportunities that will assist students in constructing and sharing knowledge through absorbing, embedding and reflecting on their learning experiences. This paper explores the role of e-portfolios in knowledge management within the context of education.

Portfolios provide students with the opportunity to document their learning journey and have become established artefacts in evidence-based practice. E-portfolios support a range of multimedia which can be included to enrich the portfolio and embrace social technologies. This paper examines a range of applications of e-portfolios in different UK Higher Education Institutions, across disciplines including education, business and computing. Differences in the purpose, use, style and assessment of e-portfolios are considered and a taxonomy of distinct approaches to structuring e-portfolios is developed. The taxonomy is then analysed in terms of the extent to which the different applications of e-portfolios provide opportunities to support the development and assessment of student knowledge. Specifically, the role of structuring knowledge within e-portfolios is considered.

The initial findings demonstrate that e-portfolios harness a student's skill in social networking, capturing their imagination and promoting engagement in knowledge related activities. The role of the artefact in stimulating and facilitating knowledge is reviewed using the theory of the task-artefact cycle. The experience of using e-portfolios in knowledge management is then compared against previous work which has explored the use of blogs as tools of knowledge construction to encourage reflection. The paper concludes by proposing recommendations for the development of learning opportunities which embrace the knowledge management capabilities of e-portfolios and considers the potential broader role for e-portfolios in knowledge management.

Keywords: e-portfolio, scaffolding, situated practice, reflection, technological knowledge artefacts.

1. Introduction

The creation and sharing of knowledge is at the heart of learning and teaching. The increasing use of social technologies, such as blogs (Hazari *et al* 2009) provides new opportunities to support knowledge management in education. This paper explores the use of e-portfolios in UK universities and considers the role of e-portfolios in creating and sharing knowledge. Three cases studies are outlined which demonstrate the use of e-portfolios in different disciplines. The theory of the task-artefact cycle is used to analyse the role of e-portfolios in creating and sharing knowledge in the case studies. A taxonomy is then constructed from the analysis of the case studies to demonstrate the range of student knowledge-related tasks that can be supported using e-portfolios and considers the extent to which scaffolding is needed to facilitate the management of knowledge within e-portfolios. The paper concludes with recommendations for using e-portfolios within knowledge management.

2. E-Portfolios

A portfolio is a purposeful collection of work (Smith and Tillema 2003). It can be used to evidence achievement and attainment of competencies (Woodward 2000, Peterson *et al* 2008) and to facilitate knowledge by documenting a learning path (Rossi *et al* 2008). Storing, distributing and managing paper-based portfolios can be difficult (Lammintakanen *et al* 2002) and these problems are addressed by e-portfolios. E-portfolios use technology to replicate paper-based portfolios by combining digitally created resources, such as photographs and documents. An e-portfolio is a subset of digital material that has been structured and presented, through a process of reflection, to meet the needs of a specific audience. Portfolios are widely used in the practice and reflection of teaching (Smith and Tillema 2003) and contribute to professional development in the workplace (Cambridge 2008). Applications of portfolios include: personal development (Stevens 2008); professional development of teachers (Smith and Tillema 2003); skill development in the medical profession (Lammintakanen *et al* 2002).

Barratt (2001) outlines three general purposes for portfolios. Firstly, portfolios can be used to support formative learning. Woodward (2000) suggests that portfolios demonstrate the development of a personal philosophy through constructing and reconstructing learning. Secondly, portfolios support summative learning. This use of portfolios is often associated with the demonstration of achievement, satisfying the need for evidence-based practices and supporting career management (Lammintakanen *et al* 2002). Thirdly, portfolios can be used for employment marketing. Stevens (2008) used e-portfolios to help adults understand and demonstrate their skills in order to seek employment. The development of the e-portfolio improved self-confidence and challenged views of the participants' capabilities (Stevens 2008).

2.1 Role of E-Portfolios in Knowledge Management

The value of the portfolio is in both the process and product (Woodward 2000). Portfolios are founded within the constructivist model, where knowledge is constructed through student participation in the learning process, and the co-constructive approach, where knowledge is constructed through internal reflection (Klenowski *et al* 2006). Collaboration, dialogue and reflection are essential elements in portfolio construction (Smith and Tillema 2003). Peterson *et al.* (2008) emphasise that learning emerges from interaction with others, forming a community of practice to share and develop knowledge (Wenger 1998).

Processes of human meaning construction are mediated not only by technology but also by the situational context, comprising rules and the community sharing the practice of this activity, interacting in the human activity system (Lave & Wenger, 1991). Knowledge is embedded within the artefacts included in the e-portfolio. Knowledge is constructed in creating the e-portfolio through the author's selection of which knowledge artefacts to include and reflection on how to present the artefacts. Portfolios are used as a final product to display the knowledge and skills of its author, demonstrating that learning has occurred (Woodward 2000) and to document and facilitate the reflective process.

The value of a portfolio can be increased if the knowledge in it can be accessed and used (Lammintakanen *et al* 2002). An e-portfolio provides a means of sharing knowledge easily, however, students can be reluctant to share their portfolios and invite comments from their peers (Smith and Tillema 2003). Knowledge is reconstructed by the audience of the e-portfolio as they interact with the artefacts within it, which provides the basis for creating further knowledge through the social process of dialogues.

2.2 Technical Artefacts in E-Portfolios

Students have experience of presenting and managing information about themselves on social networking sites such as Facebook and e-portfolios have an affinity with this form of self expression (Cambridge 2008). The e-portfolio forms a technically-based artefact for creating and sharing knowledge. E-portfolios enable knowledge resources to be easily collected and repurposed, reducing the physical burden of compiling evidence. A strength of the e-portfolio is that it enables technical artefacts created within different software packages to be drawn together, to be accessible and presented in one place (e.g. videos and documents). Combining complex knowledge artefacts in one place may offer similar benefits to the use of Mind Maps.

Lammintakanen *et al* (2002) suggest that portfolios should include both formal sources of evidence, such as competencies, skills, educational background, work environment; and informal sources of information such as observations and feedback from others, demonstrating know-how. The collection of evidence might include videos, presentations, program code, certificates, emails (Cambridge 2008); annotated photographs, pages from reflective journals and assignments (Woodward 2000); resumes, educational qualifications, references, published and unpublished work (Peterson *et al* 2008). Barratt (2001) emphasises that e-portfolios should not be electronic scrap books but a 'reflective tool'. The e-portfolio therefore also needs to include the rationale for the selection of content included (Woodward 2000; Smith and Tillema 2003).

2.3 Scaffolding Knowledge in E-Portfolios

There is debate regarding the degree of tutor-driven scaffolding (direction) that should be imposed to direct knowledge creation through the prescription of artefacts to be included in the e-portfolios. The criteria for collecting and selecting materials to be included in the e-portfolio should be based on the purpose of the portfolio (Klenowski *et al* 2006) and the intended audience (Barrat 2001). Potential audiences for a student's portfolio include employers, teachers, peers and themselves as author of

the portfolio (Woodward and Nanlohy 2004) career advisors, potential employers, professional associations, family or community members (Cambridge 2008).

In terms of assessment, Rossi *et al* (2008) suggest that portfolios for summative assessment emphasise course results whilst formative portfolios place greater emphasis on individual reflection of the learning process. There is disagreement regarding the extent to which the content of portfolios should be prescribed and the criteria that should be used to assess portfolios. Woodward (2000) suggests that flexible selection criteria is needed to allow the author to construct and reconstruct the narrative to display personal knowledge. This is supported by Klenowski *et al* (2006) and Cambridge (2008) who emphasise that learning portfolios are unique and it is not possible to capture this within a single structure. Students need to take ownership of the portfolios (Woodward 2000, Peterson *et al* 2008) and this is achieved by allowing them to control and justify the items included in the portfolio (Woodward 2000). Woodward (2000) also warns that where the content to be included in the portfolio is specified by others, the portfolio can become a repository of materials rather than a reflective learning experience. In contrast, Smith and Tillema (2003) suggest that explicit criteria regarding the content and assessment of portfolios is needed, though they also raise concerns that an emphasis on documenting evidence may oppose evaluation of the learning process. Peterson *et al* (2008) emphasise that portfolio specification aids portability and reusability, and recommends that portfolios should be standardised across Europe.

3. Case Studies

The following sections outline three cases of using e-portfolios in UK universities as a presentation of skills, a workbench and a basis for a community.

3.1 Case 1: Presentation

E-portfolios were created by first year students enrolled within a Business School. The e-portfolios were the summative assessment of a compulsory personal development module. Over a period of six months, students developed three views of an e-portfolio to present themselves to their tutors, peers, and potential employers. This enabled students to develop skills in repurposing information. The students were not given specific criteria regarding the material to be included in the e-portfolios but were guided through a series of lectures and seminars. This case reflects Stevens (2008) use of e-portfolios to record and reflect on personal achievements helping students to consider how to market their skills to potential employers.

Students were initially a little apprehensive about what to include in their portfolios. This reflects the experience of Smith and Tillema (2003) that students can lack confidence about how to collect material, particularly when the portfolio is assessed. The students enthusiastically embraced the technology. The media provided a rich source of inspiration and expression, and most students included photographs, videos and audio recordings in their e-portfolios. These often reflected cultural issues, for example, videos of their home country. In Bhosekar's (2009) study, everyday photographs were used to facilitate discussion and promote reflection about the daily life of street children. The inclusion of photographs in the e-portfolios, that were meaningful to the students, gave an insight into their world and facilitated discussion. Tutors felt that they attained a richer understanding of the students and got to know them more personally and more quickly. This reflects the holistic nature of portfolios which enables students to demonstrate personality and experience from a range of settings (Stevens 2008).

3.2 Case 2: Workbench

A common case study was used across two modules (business analysis and software development) studied by first year students on a computing degree. Students worked in project teams and the e-portfolio provided a means to integrate materials from both modules. Models were developed and combined with other resources created and used by the project team in the analysis module. These were then used to demonstrate technical skills in the software development module. In both modules, support was provided by workbooks offering guidance on the materials to be included in the e-portfolio. The e-portfolio provided a central means for communication and collaboration within the teams. The strength of the e-portfolio was reflected in the ability to integrate a wide range of resource types such as journal articles, software manuals, analytical models and program code. This enabled students to assimilate learning materials and combine ideas from both modules, helping students to share, assimilate and apply knowledge across module boundaries.

3.3 Case 3: Community

E-portfolios were developed and maintained by student teachers in an Education Faculty. The e-portfolios formed an integral part of the formative assessment and emphasis was placed on reflective dialogues, using blogs. Critical reflection enables student teachers to learn from their experience by exploring alternative perspectives, reframing problems and planning responses (Whipp 2003). Detailed guidance was provided by module tutors, regarding the resources that might usefully be incorporated into the e-portfolio to support the assessment process. In this case, the technology provided a means of communication and visibility. The range of technology used was less evident than in case one and comprised mainly of reflective dialogues and lesson plans. The e-portfolio enabled the evolution of a supportive community within which students reflected on their experience, discussed practical problems and developed their practical knowledge.

These initial findings demonstrate that e-portfolios harness a student's skill in social networking, capturing their imagination and promoting engagement in knowledge related activities. Reflection is a holistic process of making connections between and beyond course boundaries (Cambridge 2008). In case one, students were encouraged to reflect upon their learning to date, independently of courses and qualifications, to provide a holistic representation of their knowledge and expertise. In cases two and three, students were required to collect and reflect upon knowledge artefacts that crossed the boundary of course modules, which helped students to see the relationships between modules and overcome the compartmentalisation that can occur in modular courses.

4. Analysis of Case Studies

Portfolios can be categorised in a number of ways, including: purpose and setting (Smith and Tillema 2003); audience (Peterson *et al.*, 2007); characteristics and content (Greller 2007); temporality, collaboration, performance and reflection (Woodward 2000). These categories have been used in table 1 to analyse the case studies introduced in the previous section. The analysis has also considered how the cases map to the Quality Assurance Agency for Higher Education (QAA) in the UK's definitions of learning outcomes and Blackler's (1995) categories of knowledge. All three cases facilitated the development and visibility of embrained, embodied and encultured knowledge, but the cases differed within the context of the knowledge boundaries. In case two, the boundary was limited to the project type of activities within two computing modules whereas cases one and three addressed a broader scope of learning contexts. E-portfolios make knowledge visible and enable it to be shared within a community, supporting plans for future personal development (Lammintakanen *et al* 2002). This was evident in all three cases in different ways, case one demonstrated skill-based knowledge; case two demonstrated subject-based knowledge and skills and case three demonstrated analytical and reflective skills as knowledge was constructed through socialisation. In each case, the e-portfolio provided lecturers with an understanding of the development needs of both individual students and the cohort.

Table 1: Analysis of Case Studies

	Case 1: Presentation	Case 2: Workbench	Case 3: Community
Purpose	Present to others.	Present models to others and provide a usable project-base.	Collaborate with others during development of skills.
Process (Use)	Create artefacts, demonstrate abilities, document and evidence skills.	Create, use, apply and integrate artefacts.	Develop a reflective learning log.
Product	Final output of employability skills.	Final output of knowledge generation.	Final output of reflection and development.
Temporality	6 months.	Academic year.	Course.
Content	Personal photos, videos, certificates, documents and spreadsheets.	Manuals, models created, academic papers, code generated, case study resources.	Lesson plans, learning journal, academic papers, course materials.
Style Format	Free form.	Mix of recommended and free form.	Specified.
Assessment	Summative.	Summative.	Formative.
Interaction and Collaboration	1-way.	2-way exchange.	2-way collaborative.
Reflection of Author	On choice of artefacts.	On problem solving.	On practice of teaching.
Audience	Personal tutors, peers and potential employers.	Module tutors and peers in team.	Course tutors and peers.
Reflection of Audience	Skills developed.	Knowledge demonstrated.	Practice.
Type of Knowledge	Personal competencies.	Practitioner-based knowledge application and synthesis.	Community and reflective development.
QAA Skill Sets	Transferable skills.	Understanding and application.	Application and reflection.
Embrained Knowledge	Factual knowledge of the individual.	Factual knowledge of the subject.	Factual knowledge of what happened in specific situations and related learning theories.
Embodied Knowledge	Problem solving skills demonstrated by evidence.	Problem solving skills demonstrated in design models.	Problem solving skills demonstrated in reflective action.
Encultured Knowledge	Values shown by choice of materials.	Behaviour shown by treatment of resources, models developed and the use of technical terms.	Values shown within content of reflection and action taken.
Bounded Context of Content (Setting)	Individual context.	Project context (activities within the two modules).	Experiential context (teaching experience).

4.1 Role of Technological Artefacts

The concept of the human activity system uses the central proposition that relations between participants and the purpose of their actions are mediated by tools (Vygotsky 1987). The task-artefact cycle explores how the nature of a task determines the artefacts (tools) required for the task and how the nature of the artefact can change the way that a task is performed (Carroll and Rosson 1992). The creation of e-portfolios (the technical artefact) impacted the tasks in all three cases. For example, the task of demonstrating skills and abilities in case one determined the requirements for the content of e-portfolio; for example, certificates were included in the e-portfolio to evidence levels

of skills attained. However, the e-portfolio changed the way in which the task of demonstrating skill was achieved; the physical certificate was scanned and included in the e-portfolio, rather than just stating that a level of certification had been achieved. Moving from paper-based to digital-based portfolios in case one impacted the task of presenting knowledge and skills in the following ways:

- It was easier for students to evidence skills by embedding existing resources (e.g. certificates, assessed reports) into the e-portfolio.
- The wider range of media that could be included in the e-portfolio prompted students to approach the task in a different way and they were able to evidence a wider range of skills.
- Students used the available media to create new knowledge resources specifically to be included in the portfolio (e.g. video message). This enabled them to express their ideas and values.
- Students were more motivated in the task.
- Assessment of the e-portfolios was easier. Assessing e-portfolios required staff to interact with the media and choose a path through the e-portfolio, constructing their own narrative (Woodward and Nanlohy 2004). This enabled staff to attain a richer understanding of their students.

The multimodal content added depth of knowledge to the e-portfolio, providing a means to externalise tacit cultural issues which helped staff view their students more holistically. This was less apparent in cases two and three where multimedia artefacts were used more practically to illustrate key concepts. The media prompted and encouraged deeper cognitive reflection both of the artefacts and the way in which they were presented in the e-portfolio. For example, in case one, students created videos and audio files to both capture and present information.

Learning diaries are a significant component in the Faculty of Education. A reflective blog formed a major part of case three, relating to the experience of implementing lesson plans. The inclusion of a blog in the e-portfolio extended the traditional personal boundary of reflective journals. The technical artefact changed the reflective task by enabling the reflection to be shared; encouraging others to comment on the reflection and helping to develop a community of practice. Greener (2009) suggests that the primary use of blogging in teaching and learning is where reflective practice is an explicit learning outcome. Blogs can be used within knowledge management initiatives to capture, share and disseminate, knowledge, improving the visibility of learning and encouraging active participation (Ojala 2005). The social acceptability of blogging addresses some of the psycho-social, cultural, and practical barriers to reflection (Cox and Hollyhead, 2009) as blogging is not technically challenging and can be fun (Ojala 2005). However, challenges remain of how to stimulate, facilitate, encourage and assess reflection (Cox and Hollyhead 2009).

4.2 Scaffolding Knowledge

Whipp (2003) suggests that scaffolds are needed to encourage students to write higher levels of reflection and that the scaffolds need to include: questions tailored to issues raised by students, general questioning and key readings. The use of pre-defined headings helps students focus on particularly categories more intensely (Stevens 2008).

In case one, students were given little direction regarding the choice and presentation of knowledge artefacts in their e-portfolios. This resulted in personally owned e-portfolios, although common trends were quickly adopted, such as the inclusion of photographs of home. In contrast, scaffolding was provided in case three to encourage reflection and discussion of the teaching experience of the student teachers. The e-portfolio was deeply embedded into the learning context and tutors sought to direct and facilitate learning through posing questions and recommending resources. This helped maintain a constructive focus on knowledge creation as without explicit supports for critical thinking, students offer emotional support to each other rather than challenging thinking (Whipp 2003).

Too much scaffolding can hinder reflection. Cox and Hollyhead (2009) compared a structured and non-structured approach to using blogs to encourage reflection. In the structured approach, weekly questions were posed which related to technical comprehension, reflection on personal performance and reflection on the blogging process. The structured format helped to maintain student engagement in the blog but it became a log book of weekly tasks rather than a reflective journal. A less structured approach provided more opportunity for independent learning. In this approach there was a power shift from the lecturer to the student as the lecturer relinquished control of the direction

of the reflection process compared to the more structured approach. This provided more opportunity for personal reflection on the learning process, however, in practice, students focused on describing their experiences rather than reflecting on the experience (Cox and Hollyhead 2009). A balance is therefore needed in the degree of scaffolding provided to encourage purposeful and meaningful reflection.

5. Taxonomy of E-Portfolios

Further analysis of table 1 was undertaken to develop a taxonomy in which to map e-portfolios (figure 1). At the centre of the structure is explicit knowledge, demonstrated in knowledge-based artefacts presented for publication in each of the three cases. Tacit knowledge is demonstrated in the outer structures of the model, for example, within audience-based reflective practice e-portfolios, demonstrated in case three.

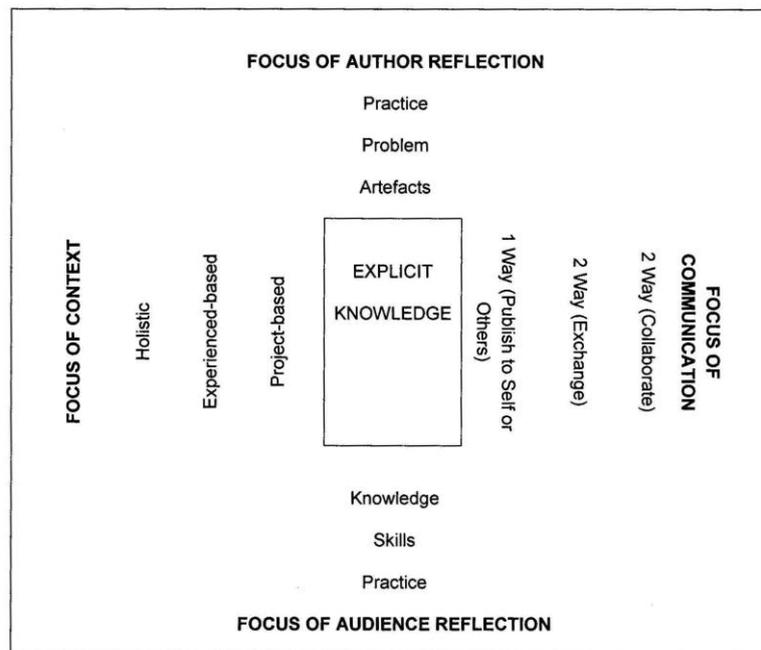


Figure 1: Taxonomy of E-Portfolios

Figure 1 highlights four main dimensions to consider:

- **Focus of Context:** The context provides the focus and scope of the e-portfolio, determining the boundary of the domain from which knowledge artefacts can be collected. The context can be project-based (case two included artefacts from two modules; practice-based (case three included artefacts related to the experience of student teachers in the classroom) or more holistic (in case one students had the freedom to include artefacts that demonstrated their skills and values and were not limited by subject or discipline).
- **Focus of Communication:** The degree of communication and interaction within the e-portfolio may be limited to a final 'one-way' publication of artefacts (case one); support the two-way exchange of ideas (case three) or support active collaboration (case three).
- **Focus of Author's Reflection:** This should include reflection of the artefacts selected within the e-portfolio (case one) and may include reflection on the wider contribution of the artefacts within a problem domain (case two) or practice-based scenario (case three).
- **Focus of the Audience's Reflection.** Much of the literature has focused on the creation of e-portfolios, however, it is proposed that e-portfolios have a broader role in knowledge management in the same way that blogs have helped learning diaries evolve to share and disseminate knowledge. At the most basic level, the e-portfolio provides explicit knowledge that an audience can assess, combine and internalise (case two). The knowledge artefacts can also demonstrate skills (case one) and prompt exploration of best practices (case three).

Figure 2 maps the three cases outlined to this structure to demonstrate the scope of knowledge activities within each case.

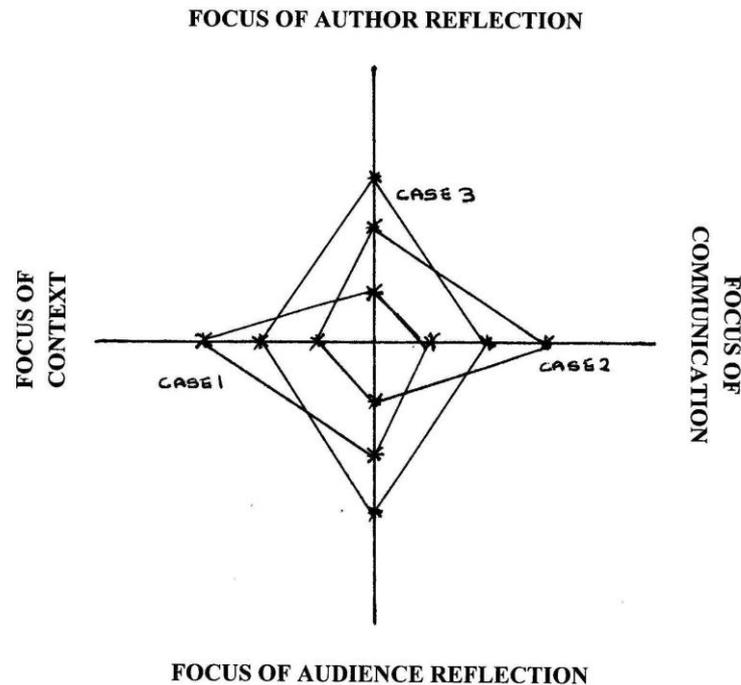


Figure 2: Cases Mapped to Taxonomy

The taxonomy provides four dimensions to consider for developing learning and assessment opportunities which embrace the knowledge management capabilities of e-portfolios. Mapping the case studies in figure 2 illustrates the different ways in which e-portfolios can be used. In case one, e-portfolios were used to present artefacts embedded with knowledge, to evidence skills. This is reflected in figure 2 by the high focus on holistic context and limited focus on communication. The focus of communication was on one way presentation; the audience had to construct knowledge of the skills being demonstrated for themselves. In the future, students could be encouraged to share and discuss their portfolios, increasing opportunities for sharing knowledge. In contrast, case two was highly focused on the communication aspect of e-portfolios, using them as a tool for collaboration. However, the focus of the context and the opportunities for reflection were limited. In the next delivery of the module, a blog will added with guided questioning to provide scaffolding to encourage explicit critical reflection on and within the problem investigated.

The taxonomy enables the provision of scaffolding, support knowledge creation with:

- Context: This sets the boundary for collecting and selecting artefacts to externalise knowledge. The artefacts trigger reflection which can be reinforced by tutor-led guidance on the explicit knowledge or skills to be demonstrated.
- Communication: Critical questioning provides scaffolding for reflection which extends beyond the direct contribution of the artefacts presented to conceptualise the reflective experience, seeking to create knowledge through socialisation.
- Author Reflection: E-portfolios provide a safe environment to reflect on materials created elsewhere, thus separating evaluation from the process of material development. Scaffolding can be used to encourage internalisation of knowledge and to develop action plans.
- Audience Reflection: Scaffolding can be used to assist the intended audience in reconstructing knowledge from the artefacts presented.

6. Conclusion

E-portfolios provide an innovative approach to encourage the creation and sharing of knowledge through reflection. In the case studies, students were motivated by the wider range of artefacts that could be included in the e-portfolio, enabling a broader range of knowledge to be demonstrated.

Scaffolding is needed to promote deeper levels of critical reflection; however, enforcing stringent scaffolds on e-portfolios may reduce the process element of e-portfolios, moving towards a product view of a knowledge repository. The fundamental principles of e-portfolios as a purposeful selection of artefacts, supported by the narrative reflection to justify their inclusion, needs to be maintained.

The cases outlined refer to student learning in specific disciplines, however, further consideration needs to be given to the potential for using e-portfolios to support organisational learning. For example, Lammintakanen *et al* (2002) suggest that portfolios facilitate the sharing of experience across hospital units and wards. Portfolios focus on personal learning but in case three the e-portfolio formed the focus for building a community of practice. E-portfolios enable readers to choose a path through the multimodal materials and future work needs to explore this interaction within the context of knowledge management.

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