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Using assignment data to analyse a blended information literacy intervention: a quantitative approach

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Abstract

The purpose of this research was to determine whether a blended approach to delivering an information literacy learning and teaching intervention (a mix of face-to-face and online activities) could statistically significantly enhance undergraduate's information discernment compared to standard face-to-face delivery.

Three interventions were designed to develop the information literacies of first-year undergraduates studying Sport & Exercise at Staffordshire University. The experimental intervention took a blended approach and combined face-to-face and online social media learning (SML) and focused on one aspect of information literacy: the ability to evaluate source material effectively. The specific aim of the study was to determine whether higher order cognitive abilities were more likely to be engaged in those who participated in this intervention over and above those who did not experience SML. Data was captured via written assessed work. An analysis was devised where written evaluations of found information were converted into numerical scores and then measured statistically via ANOVA and effect size measure. This helped to evaluate the efficacy of the interventions and provided data for further analysis.

This paper provides insight into an IL intervention which enabled participants to interact critically with information. The pedagogy that underpins these changes and the cognitive processes engaged during this intervention are discussed. The intervention which incorporated online social media learning (SML) proved to be the most successful learning and teaching approach.

The data indicated that undergraduate students' IL can be changed and developed. However, additional long-term data is required to establish whether this intervention would have a lasting impact.

These results indicate that IL practitioners who wish to foster deeper learning in their students should consider incorporating online SML and assessment into their teaching practice.

This research adds some detail to an understanding of the cognitive processes associated with evaluating information and how an assessed piece of work can demonstrate the end product of these processes.

Keywords: Information literacy, e-learning, online social network learning, social media learning, cognition, critical thinking

Paper type: Research paper

Introduction

The analysis presented here was part of a PhD study carried out by the first author and complements the pilot study (Walton, Barker, Hepworth & Stephens, 2007a and 2007b) and

qualitative findings for the main study (Pope & Walton, 2009; Hepworth & Walton, 2009; Walton, 2010; Walton & Hepworth, 2011) previously reported. The purpose of this research was to determine whether a blended approach to delivering an information literacy learning and teaching intervention (a mix of face-to-face and online) could significantly enhance undergraduate's information discernment as measured through their assessed work. Many writers in the field of e-learning have indicated that online discourse is a valuable learning tool (for example, McConnell, 2006; Mayes & DeFreitas, 2007). Furthermore, previously reported qualitative work (Walton & Hepworth, 2011) carried out indicated that students who were exposed to blended learning which included online collaborative learning (OCL), also known as online social network learning (OSNL) or the preferred term social media learning (SML), were more likely to use higher order cognitive skills such as analysis and synthesis (as defined by Bloom, Engelhart, Furst, Krathwohl & Hill, 1956) when evaluating web sites. It is argued that this greater use of higher order skills might be observed by comparing assessed work, specifically students' ability to evaluate information (information discernment). In addition, it is suggested that those who received SML will use evaluation criteria to a statistically significantly greater extent than those who did not receive SML delivery. This analysis seeks to determine whether this assertion could be upheld. The specific hypothesis drawn up to test this view is stated in the methodology section below.

Literature review

To fully explore the context of this study the literature review is divided into three sections. The first section examines the importance of IL and the current debate surrounding it. The specific definition of IL used in this study is discussed. A definition of evaluating information is also provided. Issues regarding cognition are examined in order to understand how participants might learn how to become information literate. Finally, given that this

study focuses on a learning and teaching intervention, a discussion of current pedagogical theory with respect to face-to-face and online discourse in an educational setting is provided.

The Information literacy dimension

Information literacy is a well understood paradigm which has generated its own scholarship and research (Leaning, 2009). There have been many pronouncements on the subject of information literacy in the global arena. The *Prague Declaration* (resulting from a UNESCO-sponsored conference and reported in USNCLIS (2003)), the *Alexandria Proclamation* (UNESCO, 2005) and the recent US *Presidential Proclamation* on IL (Obama, 2009) all add weight to the importance of the concept. They all seek to argue that IL is not only an important set of skills to enable information to be gathered and used but also essential for effective participation in the 'information society' and a basic human right. These statements are reminiscent of the comments made by Kuhlthau (1987, quoted in Bawden and Robinson 2002, p297) where she identified the importance of being able to read and use information as being essential for everyday life. This interest in IL has generated a wide range of materials on defining the concept and on how to teach it (see Webb and Powis, 2004; Jacobson and Xu, 2004; Cook and Cooper, 2006; Secker, Boden and Price, 2007; Lloyd, 2010; Welsh and Wright, 2010).

The 'skills agenda', initiated by the Leitch Review (Great Britain: HM Treasury, 2006) and the government response to it (Great Britain: HM Government, Department of Innovations, Universities and Skills, 2007), emphasises the critical importance of ensuring that the HE sector put the acquisition of skills at the heart of their educational agenda. It should be noted that studies which predate these reports - Cheuk (2002), Feldman (2004) and Breivik & Gee (2006) have all argued that even though the information landscape has become richer they have found that the workforce has a deficit in functional information literacy leading to a

demonstrable lack of efficiency. Furthermore, the recent study on young people's information behaviour (UCL, 2008 – also known as the 'CIBER Report') shows that pre-university students are unable to construct effective searches and use the narrowest of criteria to evaluate their newly found information. What these separate but related studies reveal is that there is a need for information literacy to underpin students' intellectual development so that the successful graduate has the skills to survive in the workplace.

Universities in the UK are beginning to address this issue, Pope & Walton (2009) argue that a strategic approach is required:

'In order to try to prepare students for this future world in which information grows at an alarming rate and in which skills are one of the keys to employability and career success, institutions like Staffordshire University must now begin to take a strategic approach to integrate the acquisition of information literacy skills directly into the students' timetable.'

(Pope and Walton, 2009, p5)

In essence this is an argument for IL to be integrated directly into the curriculum rather than for it to be taught in isolation. In other words IL should not be a subject *per se* but a thinking skills framework which empowers learners to engage with information of any kind in a given context. It is perhaps because of its perceived importance that many models of IL exist, however, they all exhibit a set of core similarities: these similarities embody a complex set of skills which learners are said to need in order to find, evaluate and use information appropriately (Buzzetto-More, 2009). Whilst the authors recognise these similarities it is argued that IL is not, in itself, a purely instrumental activity but one which is applicable in

any context. Hepworth and Walton (2009) expand on the notion of the wider applicability of IL,

“Empowerment is underpinned by information literacy. Being able to learn effectively and independently and use the knowledge, data and information [...] around them is likely to result in people having more choice. When people have choice, they are usually better informed about their situation and can see alternatives in a critical light, and then may be able to choose from or create a range of solutions or strategies. This can lead to people having more options when deciding how to participate and interact socially, and how to use and contribute to the resources and services available”.

Hepworth & Walton (2009, p3)

In short, IL is not simply a set of skills for completing assignments rather it is a framework for enabling people to think critically in any given situation whether it be in education, work, citizenship or leisure.

Therefore, it is asserted here that the definition of IL needed should align to holistic views held by Webber & Johnson (2000), Markless & Streatfield (2007) and Whitworth (2009) rather than the more standard instrumental views of ALA (1989), SCOUNL (1999; 2011), ACRL (2000) and Bundy (2004). With this in mind the definition of information literacy used for this study was as follows:

“a complex set of abilities which enable individuals to: engage critically with and make sense of the world, its knowledge and participate effectively in learning to make use of the information landscape as well as contributing to it.”

Hepworth & Walton (2009, p10)

This definition is chosen because it emerged from a qualitative study which used an information behaviour model as its theoretical base. What emerged from Walton and Hepworth’s work is that when students participated in online discourse they became more confident and articulate in critically evaluating information. This demonstrated the importance of social aspects in higher order learning – a dimension overlooked in standard models (Markless & Streatfield, 2007). In addition, students began to become producers as well as consumers of information. Finally, the study identified a complex set of cognitive, metacognitive and affective states involved in the process of becoming information literate. To give further granularity to this definition and because the focus is on improving students’ abilities in evaluating information (information discernment), the following additional definition is given: *successful evaluation of information (or information discernment) is the ability to use higher order thinking skills in order to make sound and complex judgements regarding a range of text-based materials.* This moves beyond more instrumental views of evaluating information identified by Beschman & Warner (2005). It is argued that these complex judgements would be demonstrated in the variety of evaluation criteria (or judgements) used and the frequency that these criteria were used by learners. It would be expected that learners exposed to a blended approach would deploy these criteria to the greatest extent. In turn, these notions imply that IL teaching and learning requires a shift from teaching specific resources (instruction) to enabling learners to gain set of critical thinking skills involving the use of information. A view widely recognised in HE and

education more generally (Kasowitz-Scheer & Pasqualoni, 2002; Markless & Streatfield, 2007). It was believed that this would also enable participants to engage more effectively in problem-based learning as recommended by Healey & Jenkins (2009).

The previous sections above show that much has been written on the complex nature of IL and how to teach it, however, most papers reporting on the assessment of IL tend to focus on lower level skills assessed via multiple choice tests (Walsh, 2009). For a recent example see Fain (2011). In his meta-analysis of 91 papers on assessment in IL Walsh (2009) notes that relatively little has been published regarding measuring assessed work to determine the efficacy of an intervention for higher level cognitive skills. There are notable exceptions such as Buschman & Warner (2005) and Anderson & May (2010). Buschman and Warner (2005) in the meta-analysis are critical of previous research which tends to use highly problematic self-assessment tests or indirect feedback as evidence. They recommend using actual assessed work, an approach used by Anderson & May (2010) and also deployed in the study described in this paper.

It is now necessary to examine which of the cognitive and pedagogical dimensions should be addressed in order to create a properly constructed IL teaching intervention.

The Cognitive dimension

Bloom's taxonomy still pervades education generally and in its unrevised form (Moseley et al, 2004). Some of the main information literacy models use Bloom et al (1956) explicitly such as ACRL (2000) or resemble them implicitly (SCONUL, 1999; Big Blue Project, 2002; Bundy, 2004). It seems pertinent therefore to unpack the cognitive skills identified in Bloom et al (1956) and use these as a focus in measuring information literacy components such as

information discernment (evaluating information), a skill which defines the information literate individual (Bruce, 1995). Bloom et al (1956) identified six cognitive components to learning, this study focuses on three of the higher order dimensions that of application, analysis and synthesis:

- ‘Application’ relates to making use of information and can be observed when for example, learners use their new knowledge of a title search on a library catalogue to find books from a reading list.
- ‘Analysis’ relates to taking the information apart for example, when students identify the constituent parts of the information, its order, its provenance, its value in terms of the problems and/ or solutions it generates and its consequences for example, evaluating a web page by using a set of criteria.
- ‘Synthesis’ relates to putting the information together and is triggered by asking students to identify how the information may be different, what is missing, how it can be improved or developed or how the information can be re-created by the students in their own way. For example, students can demonstrate this by bringing together suitably evaluated material found using the search skills they have learnt.

How these higher cognitive states might be engaged in the learning and teaching intervention is discussed in the pedagogical dimension section below.

The Pedagogical dimension

For an IL teaching intervention to be successful in engaging learners’ higher cognitive states it seems self-evident that current thinking in pedagogical theory should be discussed and best

practice incorporated into its design. Laurillard (1993) and Ramsden (1992) recommend that face-to-face, peer to peer interaction amongst students promotes higher order learning. Andretta (2006, p14) notes that the 'pedagogy of the question' approach can enable learners to 'identify pathways to knowledge and focus on the questions that rarely change, rather than on answers which continually change'. Hence, the tutor might for example have students identify, through discussion, a set of rules for information discernment (evaluation criteria) to help them make judgements about the value of information in any domain and medium.

Khalifa & Lam (2002) argued that online learning environments should support more interactive elements, such as online discourse, to foster learner satisfaction. Mayes (1995), Goodyear (2001), Salmon (2004), Garrison et al (2003), Nicol, Minty & Sinclair (2003), Webb, Jones, Barker & van Shaik (2004), Mayes & DeFreitas (2004; 2007), McConnell (2006), Beetham & Sharpe (2007), Godwin & Parker (2008) discuss the importance of discourse in the online environment. Salmon (2004) emphasises the need to create a highly informal social setting in the initial stages of the online discourse building towards more formal exchanges, whereas Goodyear (2001) emphasises levels of courseware. Mayes & De Freitas (2004; 2007) note the importance of drawing on learning theory to structure online learning and examine a range of theories in their analysis. Nicol et al (2003) and Webb et al (2004) specifically mention the need to use constructivist approaches where new meanings that arise from learning are negotiated through discourse. However, all confirm the power of online discourse as a way of facilitating deep learning (as defined by Marton & Saljo, 1997). Mayes (1995), reiterated by Goodyear (2001) are particularly helpful in their views regarding the way to structure online learning. They draw a distinction between three levels of courseware that should be used in e-learning, that of primary, secondary and tertiary.

- ‘Primary courseware’ is used principally to convey information to students such as online lecture notes and reading lists (Littlejohn & Higgison, 2003; JISC, 2004). Mayes (1995) and Goodyear (2001) regard this courseware as only useful in the conceptualisation stage of learning where students are exposed to other people’s ideas and concepts (JISC, 2004).
- ‘Secondary courseware’ (which includes the primary courseware element) is used largely to question and encourage reflection in students via online tests and quizzes (Littlejohn & Higgison, 2003). These are regarded as tools for carrying out learning tasks (Mayes & de Freitas, 2004) one example would be computer aided assessment (JISC, 2004). Mayes regards this courseware as vital to the construction stage of learning where learners apply new concepts in meaningful tasks (JISC, 2004). A notable example of secondary courseware is the *Internet Detective*.
- ‘Tertiary courseware’ enables the production of materials by previous and current learners in the course of discussing and assessing their learning such as, dialogue between learner and tutor or peer discussion or assessment outputs to be captured and made available for all learners. This could be material compiled from: questions and answers and discussion typically generated in networked learning (Mayes & de Freitas, 2004); videoconferencing (JISC, 2004) or simulations such as the *Virtual Microscope* at the Open University (JISC, 2004). This capturing of online material, especially online discourse, allows students to read and re-read previous contributions before posting a reply. In effect, ‘tertiary courseware’ creates a ‘cognitive space’ (Garrison et al, 2003) where students can give a far more considered reply online than in the immediacy of a face-to-face conversation. Mayes (1995) and Goodyear (2001) regard this tertiary level as the only point at which learning, via this two way dialogue, can take place. Furthermore, McConnell (2006) regards this social dimension, embodied in online

discussion and dialogue, as an essential pre-requisite in fostering effective learning in the online environment.

All the issues outlined above were taken into account in designing the blended learning and teaching intervention.

The Learning and Teaching intervention

The information literacy delivery took place within the core first year undergraduate skills module entitled *Effective learning, information and communication skills*. Based on the research literature discussed above and after testing via a mixed methods Pilot Study (reported in Walton et al 2007a &b) the following learning outcomes and problem-based assignment emerged.

The learning outcomes (LO) taken from the module handbook and addressed by the learning and teaching interventions discussed here were:

“1. Demonstrate knowledge of a range of skills required for effective learning, including [...] use if library learning resources to identify suitable information sources [...]

3. Information Technology Skills: Be able to use a windows environment to manipulate information [...].”

The more detailed intended learning outcomes devised to address LO 1 and 3 were:

“The face-to-face session is designed to enable students to address their information need in order to retrieve appropriate information for their assignment. [...]

In completing these SML Activities students will be able to systematically evaluate web sites by using an agreed set of criteria identified and developed via online discussion.”

The face-to-face workshop included a short exposition and then students used a worksheet containing exercises which enabled them to find information on the library catalogue (25mins) and an e-journals package (15mins). Each segment included a short group discussion using a questioning approach, following MacKeracher (2004), on identifying appropriate keywords. The workshop concluded with a plenary summarising what had been learnt.

The Social Media Learning Activities followed the face-to-face workshop, these were designed to enable students, through online discussion, to create a detailed set of evaluation criteria to successfully evaluate information sources for inclusion in their assignment.

Each task within the SML component (tertiary courseware) used the ‘pedagogy of the question’ approach (Andretta, 2006, p13) where students were given questions to discuss peer to peer and then provide an agreed answer. Mayes (1995) recommendations for constructing an appropriate online learning environment (later reiterated by Goodyear, 2001) were also used. In so doing, it is argued that the tutor is more likely to trigger higher order cognitive processes in learners such as application, analysis and synthesis.

The SML was structured in Blackboard as follows:

A *Forum* was created for participants which contained the title of the activity and some general guidance for example, *“This discussion is designed to help you with your assignment. Please open this discussion forum by selecting the title above and follow the instructions*

contained within the thread message". A *Thread* was then added, in effect the first posting by the tutor to the discussion board and contained more specific instructions. Finally the *Seed* text was set up to foster discussion in the following manner,

"[...] for this activity last year a student commented that she, 'always ensures that a web page is reliable before using any information on it'. So, how would you decide what makes a reliable, good quality web page?"

This was accompanied by very specific instructions and web resources to read. Once students had looked at a sample web page and evaluated it using the resources provided they then summarised, in their own words, their suggestion for evaluation criteria and posted them to the discussion board. Students would then comment on their fellow students postings.

This was done in pairs and then with the whole group. At the end of this part of discussion the tutor created a *tutor summary* which was couched in the first person and used first names and used extracts from students postings as a means of carrying on the discussion in more depth for example, *"Ringo mentioned that a good way of judging a web page can be done by 'looking at the URL address and seeing whether it is for example a government source'.*

[We] agree with Ringo regarding URLs BUT stress that we need to be more systematic in the way we analyse their structure. Have a look at the web resource and discuss how we might be more systematic in analyzing a URL."

By the ends of this process an evaluation of sources handout was produced which drew upon students own words as posted in the online discussions.

For their assignment all students were given the problem of finding and evaluating six information sources on football hooliganism to create a fictitious presentation for a group of young people.

This structure, incorporating these components, gives this intervention a strong theoretical base and ensured that it was platform and software independent.

Methodology

The specific hypothesis drawn up to test this assertion is as follows:

Students who participate in SML (via tertiary courseware as defined by Goodyear, 2001) in order to enhance their subject based information literacy skills will demonstrate a greater information discernment (ability to apply evaluation criteria) in their assessed work than students who have not been exposed to SML (that is, students who have only been exposed to primary or secondary courseware as defined by Goodyear, 2001). This will be manifest in two ways:

- (i) students who participate in SML will tend use a greater variety of evaluation criteria in their assessed work and
- (ii) students who participate in SML will tend, on average, to use these criteria more frequently.

The group which received the 'primary courseware' delivery can, in a sense, be regarded as the control group (Group C) as this is the 'normal' delivery pattern had this study not taken place. Here, the group which received the secondary courseware delivery (Group B) are denoted as the intermediate group receiving an extra e-learning dimension (in the form of an online quiz) to their delivery but not as much as the experimental group. The experimental

group (Group A) are those students who received the tertiary courseware and, bearing in mind the findings of previous studies, are predicted to perform much better than the other two groups in their assessed work.

Three groups of UK based first-year Sport & Exercise undergraduate students were involved in the study. The Faculty administration team allocated students to their tutor group alphabetically by surname (effectively at random) and all were reading for the BA award. All students were from the UK, between the ages of 18 to 20, English speaking and had completed 'A' levels at their local Further Education college (normally this includes study skills support but not specific interventions in information literacy). In total 35 students took part across three groups and the gender balance was 65% male and 35% female. The study was conducted in Semester 1 of academic year 2006-07.

It is recognised that the sample size is relatively small and so any conclusions drawn and claims made will be necessarily cautious. However, it is strongly argued here that there is no optimum level of participation for any kind of research (Bryman, 2004). Robson (2002) reports that 'rules of thumb' exist regarding approximate minimum numbers but that these vary considerably. In addition, it is accepted that large sample sizes do not *guarantee* precision but they do reduce sampling errors (Robson, 2002). Nevertheless it is recognised that, in general, larger sample sizes can deliver greater precision. What should be emphasised here is that the students involved were willing participants, that a high level of collaboration between academic staff and library staff occurred which ensured two things: one, that the research was carried out in a very positive light particularly in relation to access to students' assessed work and two, IL was integrated fully into the curriculum (Markless & Streatfield, 2007, amongst many others note the importance if this in IL delivery).

Levels of online intervention were structured to reflect Mayes (1995) and Goodyear's (2001) courseware definitions as shown above. Each group received a separate intervention as outlined below.

Group A (experimental group)

This group received one 50 minute workshop, as part of their module, delivered face-to-face and focussed on finding information. During the following week, and for the subsequent 3 weeks, the group participated in one 50 minute session workshop where SML (tertiary courseware) was used. The focus of this session was on evaluating information. This group was also given access to primary courseware elements, for example web pages and online course documents and secondary courseware elements, for example an interactive online quiz.

Group B (intermediate group)

This group received one 50 minute workshop, as part of their module, delivered face-to-face focused on finding information as detailed for Group A above. This group was also given access to primary courseware elements focused on evaluating information, for example web pages and online course documents and secondary courseware elements, for example an interactive online quiz.

Group C (control group)

This group received one 50 minute workshop, as part of their module, delivered face-to-face focussed on finding information as detailed for Group A above. This group was also given access to primary courseware elements focused on evaluating information, for example web pages and online course documents only.

During the research period Groups B and C did not experience the SML component. To ensure equality, this part of the intervention was made available to Groups B and C after the study was completed.

For this analysis the data gathered was students' written evaluations of information sources (two books, two journal articles and two web pages) submitted as part of an assessed piece of work.

Statistical analysis

To test statistical significances between groups it was decided to use a one way ANOVA. In addition, and because of the small sample size used, the Eta squared test was also employed.

Where small samples such as these are involved the measuring of effect size enables the researcher to determine how many subjects are required per group to give the test sufficient statistical power (Clark-Carter, 2003).

Results

This analysis was devised in order to test the hypothesis stated above. For this the students' actual assessed work scripts were used.

Every evaluation within each student's assessed work was examined separately. This produced, in total, 210 separate evaluations for analysis from which two sets of data were created:

1. Variety of evaluation criteria used to analyse information sources - in answer to Hypothesis part (i).
2. Frequency of evaluation criteria used to analyse information sources – in answer to Hypothesis part (ii).

Variety of evaluation criteria used to analyse information sources

Before data could be analysed it was necessary to turn the assessed work into numerical data for statistical analysis. Miles and Huberman (1994) note that data analysis can proceed systematically by identifying the number of times particular items appear. In this way, qualitative data can be given a quantitative value. To do this each use of a specific evaluation criterion was allocated a score of '1'. This established, in numerical terms, the variety of evaluation criteria that students had used in their assignments. Given the nature of this exercise there was no upper limit to the number of criteria students might have deployed in analysing their information sources.

This example shows how one student evaluated one information source found:

'This is an excellent journal because: it is published by the Howard Journal of Criminal Justice. It's published by Blackwell Publishing. The article looks at the UK legislation on football banning orders and give a critical analysis of it. The point that makes this article particularly good is the fact that it asks questions about whether

football banning orders work as a deterrent to football hooliganism. It was published this year which makes it a fantastic piece of updated text to work from.'

The way in which evaluation criteria were made into a numerical score is illustrated here. This is an example of how students had used the 'authority' criterion in their assessed work to evaluate an information source:

'This is an excellent journal because: it is published by the Howard Journal of Criminal Justice. It's published by Blackwell Publishing [...]

In this example the student has used the 'currency' criterion in their assessed work:

'[...] It was published this year [2006] which makes it a fantastic piece of updated text to work from.'

This further instance exemplifies that the 'relevance' criterion has been used in a piece of assessed work:

'[...] The point that makes this article particularly good is the fact that it asks questions about whether football banning orders work as a deterrent to football hooliganism [...]

Hence, each instance of a particular evaluation criterion used was allocated one point. Therefore (with respect to hypothesis part (i)), for the assessed work where currency, relevance and authority criteria were used a score of '3' was recorded. Where a student used only one type of criterion alone for example, the relevance criterion across the assessed work

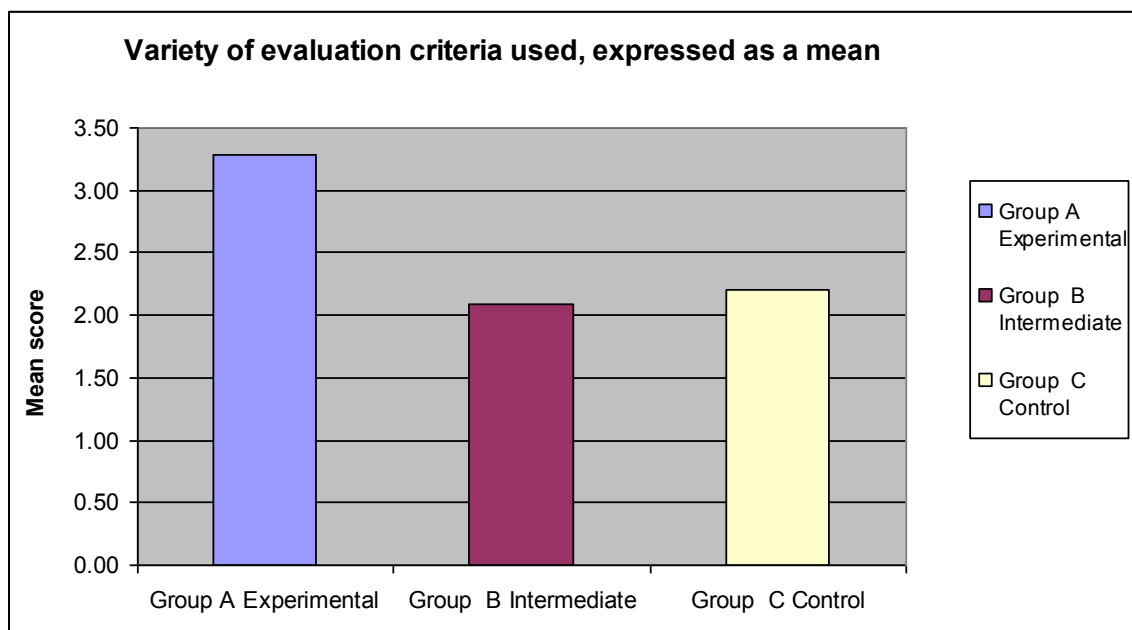
then the score allocated was '1'. A summary of scores for each Group is shown in Table 5 below.

Table 1: Descriptive statistics for variety of evaluation criteria

	Group A (experimental group)	Group B (intermediate group)	Group C (control group)
	n=14	n=11	n=10
Means	3.29	2.09	2.20
Standard deviation	1.59	1.22	1.23

Results are summarised diagrammatically in Figure 21 below:

Figure 1: Variety of evaluation criteria used, expressed as a mean



The descriptive statistics in Figure 1 above illustrates the differences between the three groups with Group A (experimental group) scoring much higher in this analysis than either Groups B or C. The one-way ANOVA showed that these differences are not statistically significant. This indicates that students in Group A (experimental group) used a greater variety of evaluation criteria in their work than either groups B or C, but that this greater use is not statistically significant.

To further investigate the possible significance of the results η^2 (*Eta squared*) was used to examine the 'effect size' for these results. . Running the test η^2 (*Eta squared* where partial Eta squared for the Group is 0.152) and then inspecting appropriate tables in Clark-Carter (2004, p604) indicates that with such a large effect size to replicate this study with statistical power of 0.8 in a future study would require at least nineteen (19) subjects per condition. In short, a large effect size exists for these results and means that if this part of the study was carried out again with nineteen subjects per condition it would have produced statistically significant results.

It is argued that in taking into account these statistics as a whole both the statistically significant results, effect size plus the descriptive statistics support the view that Hypothesis (i) can be upheld.

Frequency of evaluation criteria used to analyse information sources

Every instance that a criterion was used in the assessed work was noted to establish how often students were using these evaluation criteria in their assignment.

To transform the total number of instances that students used criteria per information source into numerical data for analysis each instance of an evaluation criterion recorded was allocated a score of '1'. This established, in numerical terms, the total number of instances

evaluation criteria were used in their assignments. Hence, for example a student who used three types of relevance criteria, two currency criteria and two authority criteria across their assessed work would be allocated a score of '7'. If this same student evaluated '6'¹ sources in total in their assignment then their average score would be '7' divided by '6' giving a numerical value of '1.17', illustrated in the formula below:

$$\begin{array}{l} \text{Average number of instances} \\ \text{of evaluation criteria per} \\ \text{information source cited} \end{array} = \frac{\text{number of instances of criteria used}}{\text{number of sources evaluated}}$$

$$\text{Average} = \frac{7}{6} = 1.17 \text{ (rounded to two decimal places)}$$

Scores obtained are shown in Table 6 below:

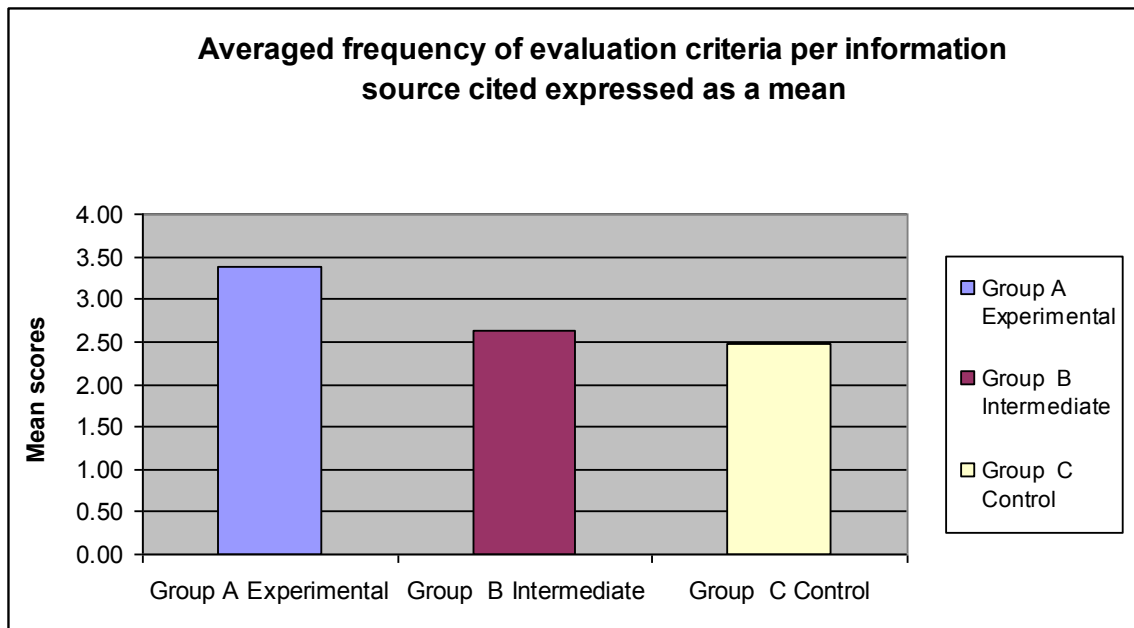
Table 2: Averaged frequency of evaluation criteria used per source cited descriptive statistics

	Group A (experimental group)	Group B (intermediate group)	Group C (control group)
	n=14	n=11	n=10
Means	3.39	2.64	2.47
Standard deviation	1.12	1.05	1.07

Scores are summarised diagrammatically in Figure 2 below:

¹ In theory all students should have evaluated six sources that is, two books, two journal articles and two web pages

Figure 2: Averaged frequency of evaluation criteria per information source cited expressed as a mean



Raw data scores for Group C (Control Group) have one ‘outlier’ – a datum which appears to be unusually high with respect to the other data gathered in the group. However, because this is real data from a real event (an assignment) it is assumed that this datum should be included in the analysis.

Using the one-way ANOVA established that differences in scores were not statistically significantly different between Groups. However, it can be seen in Figure 2 that the averaged scores were greater for Group A (experimental group) over Groups B (intermediate group) and C (Control Group).

Again, by using the effect size measure, as calculated for 'Variety of evaluation criteria' using the same method as outlined above, demonstrates a large effect size for eta squared. Running the test η^2 (*Eta squared* where partial Eta squared for the Group is 0.139) and then inspecting appropriate tables in Clark-Carter (2004, p604) indicates a large effect size and that to gain a statistically significant result in a future study would require between 20 (twenty) and 25 (twenty five subjects) per condition.

Taking into account the large effect size between Groups for this test plus the differences observed in the descriptive statistics indicate that we can make the observation that Hypothesis (ii) may be upheld. Therefore, these results suggest that Group A (experimental group) are not only using a greater variety of criteria than Groups B and C, but that they are also deploying these criteria more often within their assessed work.

Discussion

It can be seen that the written assignment task of finding and evaluating two books, two journal articles and two web pages causes students to engage in evaluating a range of information sources. However, it is those students who engaged in SML (Group A) who demonstrated the greatest deployment of the cognitive processes of *application, analysis and synthesis* in interacting with the sources they have found. This may be due in part to the online intervention which facilitates 'cognitive space' for discussion, reflection and sense making (Garrison et al, 2003). These states all appear to work concurrently in engaging with information sources. Figures 1 and 2 corroborates this view as it shows students who engaged in SML (Group A) are far more sensitised to a range of evaluation criteria which are applied more often in their assessed work than Groups B and C. The statistics show that Group A deployed a greater variety of evaluation criteria and with greater frequency. Whilst

these results were not statistically significant in themselves, effect size measures established that, had a larger sample been used, a more significant result would have been obtained between groups. This enables the hypothesis (i) to be upheld. Though statistically significant results were not found for differences between Groups A and C regarding the frequency of evaluation criteria, effect size calculations established a statistical difference, enabling hypothesis (ii) to be upheld. This not only shows the value of embedding IL in the curriculum but also indicates that using an array of teaching methods (as recommended by Markless & Streatfield, 2007) fosters increased learning. Furthermore, it tends to support the views of Mayes (1995) and Goodyear (2001) that tertiary courseware is the most successful in promoting deep learning.

Group A's ability to analyse information sources by deploying a range of IL evaluation criteria in a far more sophisticated way than Groups B and C is the most demonstrable effect that this intervention has had on students IL skills and the most interesting finding to emerge from this study. The evidence centres on the differences in the ways in which these groups used their newly learnt abilities to evaluate a variety of information. It is argued that this is significant because it demonstrates that this socially based interactive intervention has enabled participants to reach a high degree of cognitive (Bloom et al, 1956) or critical thinking (Moseley et al, 2004) or indeed 'deep learning' (Marton & Saljo, 1997) and begin to deploy the skills which define the information literate individual (Bruce, 1995; Bundy, 2004; ACRL, 2000; Andretta, 2006). In addition, by indicating the value of IL as a social as well as an individual activity in this way, it dovetails with the definition put forward by Walton & Hepworth (2001) above. Finally, it shows that by using this intervention students' functional IL skills can be enhanced and so might alleviate some of the concerns raised by Cheuk (2002), Feldman (2004) and Breivik & Gee (2006) regarding students entering the workforce.

These assertions tend to refute the claim made by the 'CIBER Report' (UCL, 2008) that once learners have left compulsory education their 'bad' searching habits are impossible to alter.

The rich data provided by the assessed work gives weight to the argument that to fully establish whether students have learnt to become information literate they should be given the opportunity to use these new skills by completing a formal assignment. It also corroborates the view of Buschman & Warner (2005) and Anderson & May (2010) that direct evidence, in the form of assignment data, can be used to test the efficacy of IL teaching. In so doing this research reaches beyond the anecdotal.

It would also appear that a by-product of this study is that assignment used here, and the subsequent analysis provides a potential model for assessing information discernment. At the very least it offers a model for further research.

Conclusion

It is recognised that this study included participants from only one academic discipline and that these results may not be transferrable to other disciplines in HE. In addition, it is also accepted that the sample size is small and caution must be used when generalising from these data. Nevertheless, it is argued that these data lend weight to the view that the SML activity had enabled students in Group A (experimental group) to use their newly learned information literacy skills to the greatest effect and thereby demonstrate the greatest level of information discernment. The reasons why we can hold this view are because in the assessed work calculations indicate that whilst statistical significance is not present in either evaluation criteria test there is a large effect size for both. By taking into account effect size in this way, as recommended by Clark-Carter (2003; 2004) allows both parts of the hypothesis (i and ii) to be upheld. It also permits the conclusion to be made that if the study were to be replicated

with a larger sample size statistically significant results would be obtained. This view is further reinforced when these data are triangulated with qualitative data findings reported previously (Walton & Hepworth, 2011).

The η^2 (*Eta squared*) statistical test proved a useful addition to the standard ANOVA. In the light of this it is recommended that practitioners consider using this test to further examine data that might appear, at first glanced, to be showing no significant differences or effects between groups.

In addition, to facilitate higher order learning it is strongly recommended that practitioners who deliver information literacy learning and teaching interventions seriously consider using a blended approach, which includes online discussion. Finally, it is also recommended that practitioners consider using the problem-based assignment presented here as a model for assessing higher order IL cognitive skills.

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