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Instructional design for the active: Employing interactive technologies and active learning exercises to enhance information literacy

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Abstract

In a variety of instructional scenarios, librarians at The University of North Carolina at Pembroke have been working to engage students with the use of interactive technologies combined with active learning strategies in attempts to enhance learning of information literacy (IL) skills. This paper describes the successful use of this approach in not only increasing student engagement, but also learning outcomes for performing specific competencies such as creating effective search strategies, evaluating information sources, and making distinctions between scholarly and popular publications. Practical examples of our use of class response systems (clickers), interactive whiteboards, wireless slates, and digital cameras in conjunction with active learning environments are discussed in the context of IL provision for both upper- and lower-division classes. An experiment using clickers reveals the specific impact that this technology can have regarding learning outcomes and student engagement, while discussion of the use of other technologies provides a practical look at implementation.

Our study (n=234), focusing on the provision of information literacy sessions for English Composition II classes to a 'clicker' group and a control group, revealed a four-point increase from the pre-test to the post-test in the development of information-seeking competencies for students in classes using clickers and discussion, compared to classes using the lecture as a primary method of instruction. The results of these experiences shed light on the potential impact that implementation of interactive technologies, with a shift in pedagogy toward active learning, can have on student engagement and learning of information literacy concepts. While increased student engagement is evident with the use of these technologies, more research on the implementation of active learning in the context of information literacy instruction is needed in order to test the conclusion that learning outcomes can be successfully achieved as well.

Keywords

information literacy; instructional design; active learning; instructional technology; academic libraries; learning outcomes; assessment

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1. Introduction

Interactive technologies have become ubiquitous in higher education as a means of delivering learning content to students in a more engaging manner. But according to West (2005), it is an accompanying pedagogical shift used to implement a new classroom technology, not the technology in and of itself, which can be given credit for any improvement in achievement of learning outcomes.

The idea of promoting 'active learning' in the classroom has struck a chord with educators for the way that it enables instructors to accommodate varying learning styles and encourage active participation of students (Bonwell and Eison, 1991, pp. 1). Active learning is essentially the antithesis of passive learning, the teaching method that relies strictly on one-way communication from teacher to student. Passive learning is most often associated with teaching styles that incorporate lectures, note-taking, and the memorisation of facts. Gamson and Chickering (1987,

pp. 4) believe that students do not learn by passively sitting and listening to teachers, and instead must talk and write about what they are learning in addition to being able to relate it to past and current experiences. According to Bonwell and Eison (1991, pp. 5), students prefer learning environments where active learning is employed to traditional lectures. They defined active learning as "instructional activities involving students in doing things and thinking about what they are doing". Active learning strategies have become popular because they are believed to increase development of thinking and writing in students who participate more actively in the learning process. This approach also offers teachers multiple ways of reaching learners that perform better in non-traditional lecture environments.

Librarians at The University of North Carolina at Pembroke have merged the pedagogical approach of active learning with interactive classroom technologies in an attempt to increase student engagement and participation in information literacy instruction sessions. This article will discuss the successful design of information literacy sessions targeted to undergraduate students that employ active learning strategies in conjunction with the implementation of interactive technologies, including classroom response systems (clickers), interactive whiteboards, wireless slates, and document cameras.

2. The adoption of active learning and clicker technology

Researchers have become interested in how interactive technologies can best be used to maximise student engagement and possible retention of information. In our research, we investigated a pedagogical shift from more traditional methods of instruction to an active learning approach. Active learning is considered a pedagogical strategy that is derived from Constructivism, a philosophical approach to learning that attempts to "create learning situations that promote the engagement or immersion of learners in practice fields" (Reiser and Dempsey, 2007, pp. 42, 46). These learning environments should ideally include activities that are authentic to the discipline or content being learned. As mentioned earlier, in active learning, the focus of learning moves from an instructor-centric environment to one that is learner-centric, meaning the emphasis is no longer placed on how the teacher teaches but on how the student learns. The student gains a far better understanding of the material when she is able to play a role in participating in the shaping of content, instead of simply having it dictated to her through one-way communication (Leonard, 2002, pp. 3).

Interactive technologies, such as whiteboards and clickers for example, offer a way for instructors to enable learners to actively participate in how they receive and retain information. When combined with active learning environments that encourage class discussion and student participation, these technologies help to create new pathways to learning. Compared to traditional lectures and note-taking, combining active learning techniques with interactive technologies provides students with greater opportunities to directly engage with content.

Fink has outlined three strategies for implementing effective forms of active learning into the classroom. One of these strategies is to "find new ways to introduce students to information and ideas" (Fink, 2003, pp. 114). By experimenting with new technologies, such as clickers and electronic whiteboards, students are experiencing a variety of new learning tools that promote engagement with course content, serving as an alternative to simply reading a text or passively listening to a lecture. This exploration of interactive learning in the classroom increases the likelihood of reaching more students in an environment of pupils that possess varying learning styles.

Most of the available research regarding the use of clickers, which can also be referred to as classroom response systems (CRS) or personal response systems (PRS), speaks to the affective benefits of their use in the classroom. This includes the increase in level of student engagement, increased student interest, and overall increase in participation and interactivity (Martyn, 2007, pp. 72). However, there is a lack of evidence in the literature showing an increase in learning outcomes of information literacy objectives, such as search strategies and evaluation of sources. In

some cases, clickers have been shown to be equal or less effective than other traditional methods and the study discussed in the following section attempts to shed some light on this claim.

3. Using clickers to deliver IL for English composition II

In the spring of 2010, librarians at The University of North Carolina at Pembroke conducted a study comparing the use of clickers/discussion versus the use of lecture during information literacy instruction sessions for the English Composition II (ENG 1060) course. This compulsory first year undergraduate composition course emphasises critical reading in the disciplines and research skills using various writing strategies with a focus on analysis and argumentation. Students are required to produce a 2,000-3,000-word argumentative/persuasive research paper and final writing portfolio, which consists of documentation of the students' progress such as drafts, edits, and printed copies of sources, used to aid the instructor in the grading process. As a result, a majority of ENG 1060 instructors bring their section(s) to the library for a one-off instruction session on accessing and searching the library's article databases. Traditionally, these sessions were taught using lectures combined with demonstration of databases. In the hope of encouraging more active participation and better retention of knowledge, we incorporated the use of clickers and class discussion.

In the study, a total of 15 classes of ENG 1060 were randomly assigned to two groups. The clicker group consisted of seven sections and a total of 117 students, while the control group consisted of eight sections, also with 117 students. Both groups were given the same presentation/demonstration combined with the use of feedback questions posed by the librarian. The only difference between the two groups was the method by which the questions were posed and responded to. In the clicker group, questions were posed to students via the presentation software that accompanied the clickers, and each student would respond with the use of a handheld clicker device connected to a radio frequency receiver. There were a total of three clicker questions posed to the students over the course of each 50-minute session and following each question, the librarian facilitated a class discussion centred on the responses given by the students. On the other hand, the control group was posed the same number of questions verbally from the librarian, and students were asked to answer each question by a show of hands. These sessions were designed with the following learning objectives in mind, based on the ACRL's Information Literacy Competency Standards (2000), which states that the student will be able to:

1. create effective search strategies
2. successfully utilise basic database functions
3. successfully identify parts of an article citation
4. revise search strategies (narrow, broaden)
5. manage extracted citations

To assess learning outcome achievement, a pre-test and post-test were administered to each group. The tests consisted of 10 questions that reflect the outcomes described above (see Figure 1 below). The questions on each test were identical, except for some affective learning questions that were added to the bottom of each test. Results of affective questions are discussed in the next section.

Figure 1: Test questions

1. If you have trouble finding articles in a database you should **first**:
A. Try the Internet
B. Change your keywords
C. Try a different database
D. Use Wikipedia

2. An article **citation** usually includes which of the following information?
A. Your account information
B. The library call number for that particular article
C. The author, title, and date
D. A list of better sources

3. **Relevance** ranking in library databases allows you to do which of the following:
A. Sort the articles by importance
B. Sort the articles by date published
C. Sort the articles by length
D. All of the above

4. **True or False** – Multiple databases on different subjects can be searched at the same time.
A. True
B. False
C. It depends

5. The purpose of **Journal Finder** is:
A. To locate a book in the library
B. To locate an article when the full text is not available
C. To locate a credible website on your topic
D. None of the above

6. Once you find an article that you would like to use, you may:
A. Locate a shorter version
B. Pay for it from your account
C. Try to find it on the Internet
D. E-mail, save, or put it in a folder

7. The research paper topic you are given is **"Do teen magazines contribute to eating disorders among teenagers?"** If you were searching a database for articles on this topic, which of the following keyword combinations would be the best search strategy?
A. magazines and eating disorders
B. teenagers and magazines and eating disorders
C. eating disorders and teenagers
D. teenagers and weight loss

8. A **journal article** is more likely to have been written by:
A. A reporter
B. A professor
C. A military officer
D. A stock broker

9. The **summary** of a journal article is also known as:
A. A citation
B. A reference
C. An abstract
D. None of the above

10. You are interested in purchasing a hybrid automobile from a foreign manufacturer. You searched for *Honda* and got 17 hits. Which of the following searches would help you retrieve **more** than 17 hits?
A. Honda OR Toyota
B. Honda AND Toyota

The sessions were conducted during one 50-minute class period, with class sizes no larger than 20 students. To begin each class, the librarian administered a paper-based pre-test which students were asked to complete within the first five minutes of class. After these were collected, the librarian posed the first question, which attempted to gauge some preliminary information on student experiences with research. This was also used to assure that technology in the clicker sessions was functioning properly. Next, the librarian proceeded to facilitate a brief discussion on the use of keywords, Boolean operators, and truncation in searching, followed by how information is organised by subjects. A second feedback question was then administered to gauge student retention of the content covered thus far. Following the responses, the librarian had the opportunity to clarify or clear up any confusion exhibited by students through the use of discussion. The librarian then demonstrated searching for articles in a multi-purpose database based on a theoretical topic, followed by an explanation of parts of a citation. Again, a feedback question was posed to gauge understanding of these concepts. The lesson ended with a discussion on managing citations and was followed by the 10-question post-test.

3.1 Results from both clicker and control groups

Analysis of the results from the two groups' tests indicate that the active learning approach, coupled with the use of clickers, did indeed result in increased learning outcomes for the clicker group over the control group. For the sample out of 117 tests, the traditional group scored a mean of 63.33 on the pre-test, with a score of 77.94 on the post-test, giving a differential of 14.61. This is a very positive increase, but the clicker group fared even better. With the same sample size, the mean on the pre-test was slightly higher at 67.26 with an even larger increase in post-test which generated a score of 85.89 and a difference of 18.63. Overall, the clicker group performed better than the control group by an average of 4.02.

Additionally, each test consisted of a group of affective learning questions at the end to gauge students' feelings about the session itself. Using a Likert Scale of 1-5 (with 1=Not at all and 5=Very Much So), students in both groups were asked two questions. When asked 'How much did you enjoy today's session?' the control group answered with a mean of 3.62, while the response from the clicker group was 3.79. When asked 'How engaged did you feel during today's session?' the control group answered with a mean of 3.68 while the response from the clicker group was 3.82. The clicker group was also asked the additional question 'Did you prefer using clickers over traditional classroom lecture?' to which the mean response was 4.16. Responses to these questions show that the clicker group scored a higher average, suggesting that students were more involved in the learning process, thus more likely to achieve the designated learning objectives.

The increased level of engagement and participation observed by the use of clickers in the classroom that was shown by this study is confirmed by the literature. Librarians teaching a for-credit, elective information literacy class (LIB 100) at Wake Forest University elicited overwhelmingly positive student responses in their experiences using clickers (Collins et al., 2008). Deleo et al. (2009, pp. 443) also found that the use of clickers "permitted both students and librarian a chance to address weaknesses in information literacy skills, reveal misconceptions, and replace inadequate knowledge as it fosters greater engagement". Moreover, in another study that compared clicker versus non-clicker sessions, librarians again observed that students found the clicker sessions more enjoyable and better organised (Corcos and Monty, 2008).

However, as some have discovered, clicker technology alone does not always provide for increased learning outcomes compared to other methods of delivery. In Dill's study (2008), a post-test revealed that the control group scored a slightly higher average than the clicker group in retention of information literacy concepts. In another study, Martyn (2007) observed a similar result whereby the control group averaged a slightly higher score than the clicker group. Although the sample sizes used in these studies were significantly smaller than the one used in study (n=46 and n=68, respectively), there is evidence that clicker technology will not by itself foster achievement in learning outcomes. This study shows that clicker technology matched with an active learning

strategy of promoting class participation and discussion provided not only for increased engagement and interaction, but increased learning outcomes as well. The success of this study compared to others can be attributed to our use of active learning principles in the design process instead of solely relying on the technology to produce results. By encouraging class discussion of IL concepts based on student responses, students became more engaged and were able to play a greater role in their own learning.

4. Use of other technologies in the context of active learning

4.1 Interactive whiteboards

At The University of North Carolina at Pembroke, we decided to employ interactive whiteboards in our library instruction sessions for the purposes of encouraging active learning and student engagement. The incorporation of this technology in delivering information literacy is discussed in the following section. An interactive whiteboard (IWB) is an interactive display surface that is used in conjunction with an instructor workstation and a mounted projection system. Interactive whiteboards can be attached to a wall or placed on a stand with castors, thus making them mobile. They come in various sizes and are manufactured by a variety of companies. Also known as a SMART Board, the IWB used to conduct our information literacy sessions is a wall-mounted unit on the front wall of our electronic classroom. The board itself measures 4 feet by 5 feet.

The trademark of IWBs is the ability to interact with and manipulate the displayed content by using one of the electronic pens provided or one's finger. Most IWBs, along with the appropriate software applications, allow the instructor to annotate concepts being presented. Accompanying software allows instructors and students to go beyond what is possible with traditional instruction tools. For example, presentations by the instructor or the students can be recorded as static documents or as videos and uploaded to a course site. Such capabilities allow for the creation of valuable resources that can be referred to later when working on related assignments. It also allows for the use of creative and dynamic documents, and the touch-screen technology offers greater fluidity in the presentation of the materials.

IWBs have been used in educational settings for well over a decade now. There are numerous enhancements that come with most IWBs that can be used in powerful ways to attract the attention and interest of participating students. In other words, they can serve a variety of pedagogical purposes, and make great instructional tools for enhancing information literacy instruction. The vast variety of applications of interactive whiteboards appeal to students with mixed learning styles, making them great tools for active learning exercises.

We use our IWB to promote active learning to gauge the students' previous knowledge and as a tool for immediate reflection. Depending on the course and how much time is available (some course sections do come to the Library for multiple instructional sessions but many do not), we ask a student or two to come up to the board to show some baseline process such as keyword searching using the Library's online catalogue. For courses that come to the library for multiple sessions, students are selected to come to the board to present some piece of database functionality and outline the different parts of a citation for a scholarly journal article. This serves to ascertain the students' acquisition of skills from the previous session and also provides for some peer-to-peer learning opportunities. This type of exercise invites a competitive atmosphere where students explain to one another different ways of searching or limiting results that others may not have thought about previously.

We also use the IWB to develop critical evaluation. In many of our information literacy sessions geared toward first year undergraduate competencies, we teach students how to critically evaluate websites for reliable, academic content. During these sessions, librarians will use a PowerPoint presentation that includes screengrabs of several different webpages dealing with a specific subject matter. The purpose of the exercise is to get students thinking about the 'Who, What, Where, When, and Why' of the content – what we refer to as the 'Five Ws'. By addressing each of

these elements, students begin to learn to scrutinise a webpage for certain characteristics that will help them make an informed decision about the authoritativeness of a website.

We may show, for example, a webpage dealing with the Iraq War. At this point, we ask for volunteers to come to the board and annotate and point out different characteristics of the site which may help to explain why that particular site can be considered trustworthy or not. For example, a student might come to the board and identify and circle a link to a description of the organisation responsible for publishing the information, or underline and draw arrows to the credentials of an author. Students in the audience are then encouraged to point out other elements that may buttress or refute claims that the site is credible, often leading to constructive debate. The students are in a sense doing the teaching and the learning while the librarian is merely providing the forum and facilitating the discussion, and the whiteboard technology provides the vehicle for that facilitation.

We also use the IWB in our Freshman Seminar (FRS 1000) information literacy programme, whereby students work in groups to complete information-seeking tasks that are eventually submitted to the instructing librarian in the form of a worksheet. The students use the IWB to present their group work findings (e.g. the best search strategy for finding articles on the prevention of childhood obesity) to the rest of the class. This type of reflection and peer-teaching allows librarians to present information literacy concepts, such as how to select appropriate resources for specific research tasks and how to revise search strategies in article databases, in ways that may appeal to learners of non-traditional styles.

So far in our experimentation, these types of active learning exercises in conjunction with the interactive whiteboard have been shown to be successful in engaging our students much more effectively than previous traditional methods. Almost all of our evidence comes from surveys and quizzes which generate textual responses in the form of anecdotes relating to experiences using this technology. Analysis of this data is in a preliminary stage, and thus cannot be used to state what impact this technology has on learning achievement. A more systematic analysis is called for in order to determine the pedagogical impact of using IWBs in information literacy instruction. For now, we are satisfied with the level of increased engagement and affective learning outcomes exhibited by our students.

4.2 Wireless slates and document cameras

Another successful application concerns the use of wireless slates and document cameras in an information literacy lesson designed for upper-level business students. In the Management 3090 course, students are asked to conduct research using peer-reviewed journal articles in both print and electronic format. Our goal in providing the sessions for this course is to familiarise students with the differences between scholarly and trade publications (e.g. Harvard Business Review, Advertising Age, Publishers Weekly), while also promoting in-class participation and stimulating group interaction, thus creating an active learning environment.

The sessions were designed to follow an outline consisting of four segments: A lecture/discussion using a document camera to project images of business periodicals; an interactive class activity using wireless slates; a librarian-led demonstration of a business database; and time at the end for individual hands-on searching.

The session where these technologies are used starts with the librarian facilitating a lecture/discussion on the characteristics of scholarly and trade business publications. This exercise is used to gauge prior knowledge that students have in using periodicals, and serves to get participants involved with the discussion. The librarian fills in any knowledge gaps, particularly when key concepts (such as the presence of advertisements or credentials of authors) have been omitted from student responses. Once the librarian has assessed the students' level of understanding about periodicals; he then proceeds to project images of pages from business periodicals both scholarly and popular onto the white board at the front of the classroom.

These images are created and magnified through the use of a document camera, also known as a digital overhead. Document cameras are high-resolution webcams that are mounted on arms in order to allow instructors to display and write on sheets of paper or display two or three-dimensional objects on-screen while the audience observes. Each image depicts a page from a magazine or journal that contains a characteristic or piece of evidence that could be used to describe whether or not a publication is scholarly in nature. For example, an interior page of the Economist magazine might contain an advertisement, which would indicate that the periodical is not scholarly. As the librarian projects each image, a wireless slate is circulated around the classroom and the students use this slate to locate and annotate aspects of the periodicals that would indicate scholarly or trade publications.

Wireless slates are interactive classroom technologies that look a lot like small tablet PCs. They are thin, light, work in conjunction with our interactive whiteboard and instructor workstation, and are designed to be used by the students during the session. Using a tethered electronic pen (or a wireless mouse) to interact with the wireless slate, participants can control any computer function or annotate any screen being displayed from remote locations within the classroom. Essentially, this allows multiple classroom participants to engage with one another and the instructor simultaneously while visually interacting with the same screen or application.
Using a wireless slate, students are engaged in the learning process because they are asked to participate and become involved by annotating and explaining how something on a periodical page might help them determine which type of periodical we are looking at. Once an annotation is made, the librarian then facilitates a discussion to get feedback from the rest of the class. Discussions often centre on many different characteristics of the pages such as: length of articles; appearance of covers; credentials of authors; and presence of images or advertisements. By the time this segment of the session has ended, everyone in the class has had an opportunity to participate.

To conclude the session, students receive a librarian-led demonstration on how to search one of the prominent business article databases for finding peer-reviewed articles. This is followed by a period of 15 minutes or so where students can begin getting hands-on practice in searching for articles based on their topic. This practice reinforces the skills learned earlier in the session, while providing students with an opportunity to gain exposure to new resources while having a librarian nearby to answer questions.

We follow up the session using wireless slates and document cameras with an assessment at the end of the period consisting of a five-question survey that measures both cognitive and affective learning outcomes. In response to a question dealing with identification of characteristics of these periodicals, the two classes (n=47) scored 92%. On a question dealing with target audiences, the classes scored 67%. In response to a question regarding citation of these publications, the classes scored just 50% - this proved to be the toughest concept to grasp, while in response to a question regarding database features, the students scored 83%. One question focused on affective learning asking the students if they were now confident in being able to distinguish the difference between scholarly and trade business publications, to which all but one student answered ‘yes’. Based on observations and data from the post-assessment, it was clear that students were once again engaged by the technology used in an active learning environment. It was unclear however, whether the approach had any positive impact on learning outcomes as assessment data revealed both strengths and weaknesses in responses to questions testing specific knowledge.

5. Conclusion

Technological innovation over the past decade or so has resulted in a wide array of new instructional tools. Educators around the world are increasingly willing to experiment with these tools to find ways to further engage students in the classroom. Librarians too are always looking for ways to increase student participation and learning of information literacy skills. As pointed out by some of the literature, however, the use of these technologies alone has not provided sufficient evidence to support assertions that they do in fact positively contribute to increases in learning outcomes:

> Many uses of technology have anecdotally been successful in keeping students engaged and involved with the material presented. It is often unclear, however, if these novel techniques for imparting library information and research skills have a positive effect on student learning and retention of material. (Dill, 2008, pp. 527).

Based on experiments over the past year, librarians at The University of North Carolina at Pembroke have discovered that a pedagogical shift accompanied by implementation of interactive technologies can in fact promote the achievement of learning outcomes in some instances. This pedagogical shift from traditional teaching methods, such as lectures, to active learning strategies can make all of the difference in moving beyond engagement to actual promotion of retention of information, and our study regarding the use of clickers points to the potential that does exist in this respect. One thing this study has not determined is whether or not these technologies can have a long-lasting impact on information literacy practices of students. Further research is needed to ascertain the validity of this claim and also to test the idea that interactive technologies positively impact affective learning, particularly in the context of active learning in information literacy.

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