CONSTRUCTIVISM IN THE DESIGN OF ONLINE LEARNING TOOLS

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Abstract: Online learning tools are often designed with a technology-driven view rather than a learning-driven one. This has often led to the failures of e-learning initiatives especially in higher education settings. This paper presents a study to map the use of constructivism as the theoretical basis for the design of online learning tools. A total of 39 selected journal articles were used as the data for this qualitative investigation. An analysis was carried out on the data and the results were noted in a set of matrix displays. The process was then reviewed by an expert panel acting as inter-raters. The findings indicate that constructivism is often used for online learning tools and activities related to communication and collaboration.

Keywords: online learning, design, online communications, constructivism.

INTRODUCTION

The growing use of the web for educational purposes led to the development of various forms of web-based technology for use in education. While these technologies are touted as helpful or even revolutionary, little has been done to clarify or establish their relationship to what we understand of human learning. Various platforms exist to cater for the growing demands of online learning in the forms of learning management systems and virtual learning environments. These platforms come with a plethora of tools claimed to help with learning; and here lies the problem. The claims made by vendors or makers of these platforms are usually not substantiated; they function more for the purpose of promotion and marketing rather than any indication of the platforms’ value to teaching and learning.

This paper discusses a research carried out in order to help determine the kinds of online tools that are normally associated with the constructivist theory of learning. The aim of the paper is to provide a mapping of the principles of constructivism onto the design of tools for online learning based on selected literature on the subject of online learning. It is hoped that the findings could be used as one of the guides for educators in higher institutions of learning to decide on their choice of platforms for online learning.
Constructivism is a philosophy that, at its most basic level, views reality as constructed internally by a person as opposed to the objectivist view of reality being fixed and external. The constructivist view of learning and education has been enjoying a significant dominance in educational thoughts for the last two decades. It has been described as a paradigm shift from earlier views of learning (Herod, 2003).

When it comes to learning, rather than being a unified theory in itself, constructivism forms the philosophical basis for a few learning theories. These theories share the view that learning involves an active process of knowledge construction, and teaching is about supporting and upholding that process rather than simple transmission of knowledge from teacher to student (Duffy & Cunningham, 1996; Von Glaserfeld, 1984; Vygotsky, 1978; Wells, 1995; Wittrock, 1990).

Fosnot (1989) presents four tenets for constructivism. The first is that knowledge depends on past constructions which exist as a mental framework. Knowledge can be gained by deconstructing and reconstructing this framework as the result of our interactions with the environment and experiences. Second, constructions are a result of the processes of assimilation and accommodation. Familiar information is assimilated into our mental framework, while accommodation occurs when the information is not familiar and we accommodate it into our mental framework by developing a higher level theory or logic.

Third, learning is an organic process of invention. Knowledge is not all factual and static. It has to be continuously constructed and enriched by investigation, predicting, imagining, manipulation of information and invention. And finally, meaningful learning involves reflective learning that seeks to resolve cognitive conflicts by improving on the prior framework or understanding.

Norton and Wiburg (2003: 35) sums up the features of what they term ‘efficiency learning’ (behaviorism) versus constructivist learning in Table 1:

**Table 1: Efficiency learning vs. constructivist learning**

<table>
<thead>
<tr>
<th>Efficiency Learning</th>
<th>Constructivist Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers present; students listen.</td>
<td>Teachers facilitate; students do, present, think, construct.</td>
</tr>
<tr>
<td>Working together is cheating.</td>
<td>Working together facilitates learning and problem solving.</td>
</tr>
<tr>
<td>Subjects are presented separately.</td>
<td>Subjects are integrated into a learning whole.</td>
</tr>
<tr>
<td>Learning is fact-centered.</td>
<td>Learning is problem centered.</td>
</tr>
<tr>
<td>The teacher is the source of all knowledge.</td>
<td>There are many rich resources for learning.</td>
</tr>
<tr>
<td>Print is the primary source of information.</td>
<td>Concepts are explored using a variety of communication tools.</td>
</tr>
<tr>
<td>Assessment is based on how much is memorized and can be given back to the teacher.</td>
<td>Assessment is based on each student’s developing abilities to solve problems, communicate ideas, present information, and learn how to learn.</td>
</tr>
<tr>
<td>Schools are isolated and separated from the rest of the community.</td>
<td>Technology connects the world to the classroom and the classroom to the world.</td>
</tr>
</tbody>
</table>

Source: Norton and Wiburg 2003
The constructivist view of learning dominates much of the literature on online learning, both in recognition of the importance of the social aspects of online learning and the flexibility it affords to diverse student needs (Clerehan et al. 2003; Miller & Lu, 2003).

Duffy and Cunningham (1996) argue that within a constructivist framework, technology is a means to expand cognition i.e. it makes possible varied learning activities that are dynamic, rather than just a simple redistribution of cognitive labor. They focus on the role of technology as a tool for the learner. Chen et al. (2000) expanded on this view by listing the categories of tools: Informative Tools, Communicative Tools, Constructive Tools, Co-constructive Tools and Situating Tools.

Informative Tools are defined as tools that act as repositories of digital knowledge in various formats (textual, sound, graphics or video). Examples given are multimedia encyclopedia and online resources. Chen et al. (2000: 190) defines Communicative Tools as “systems which enable easy communication between the teacher and the students or among students beyond the physical barrier (either by space, time or both)”. Examples given are email, electronic bulletin boards, chat, teleconferencing and electronic whiteboards. Constructive Tools are tools that can be used to manipulate information in various formats in order to create something that represents a learner’s knowledge or understanding of a concept. Examples given are concept maps and publishing software (both desktop and web-publishing). Co-constructive Tools are similar to Constructive Tools as the name suggests; however, here the students work collaboratively instead of individually. An example of the tool is the electronic whiteboards. Situating Tools are “systems which situate users in environment where they may experience the context and happenings” (Chen et al. 2000: 198). Examples given are simulations, Virtual Reality, MUD (Multi User Dungeons) and MOO (MUD Object Oriented).

Duffy and Cunningham (1996) divide constructivism into two facets: cognitive constructivism and social constructivism. Social constructivism differs from cognitive constructivism in that it views knowledge as socially constructed. This gives the premium on collaborative and corroboration works among the learners and the teacher (Norton & Wiburg 2003; Palloff & Pratt 1999). McMahon (1997) in arguing that social constructivism is suited for certain uses of the web for education says that:

“It could be argued that the use of the Web is best suited to that of a communications medium for collaborative approaches to learning rather than as a "24 hour a day glorified whiteboard" (Archee & Duin, 1995). Such a use would involve a high level of social rather than physical interaction; an aspect well supported by the Web and integral to a Social Constructivist approach.”

Chen et al. (2000: 188) provides a summary of the features of constructivism and social constructivism as shown in Table 2:
### Table 2: Summary of constructivism and social constructivism

<table>
<thead>
<tr>
<th>Learning Framework</th>
<th>Constructivism</th>
<th>Social Constructivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumption</td>
<td>Knowledge is constructed by the individual.</td>
<td>Knowledge is socially constructed.</td>
</tr>
<tr>
<td>Definition of learning</td>
<td>Students build and apply their own knowledge.</td>
<td>Students socially build, share and agree upon knowledge.</td>
</tr>
<tr>
<td>Learning Strategies</td>
<td>Collect unorganized information from the world and create concepts and principles.</td>
<td>By exchanging and sharing notions with others, ideas are formed and thinking occurs.</td>
</tr>
<tr>
<td>General Orientation</td>
<td>Personal discovery of knowledge.</td>
<td>Learning is a social construction, mediated by different perspectives.</td>
</tr>
<tr>
<td></td>
<td>Discover relations between concepts, e.g., addition and subtraction.</td>
<td>Through authentic projects, students discuss and discover meanings, e.g., the concept of multiplication. Teachers provide for facilitation and scaffolds among students.</td>
</tr>
<tr>
<td></td>
<td>Teachers provide instructional context for active and self-regulated students</td>
<td></td>
</tr>
<tr>
<td>Example</td>
<td>$8 \times 5 = 8 + 8 + 8 + 8 + 8$</td>
<td>Two job offers, same salary:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Option one – 8 hours/day for 6 days/week.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Option two – 9 hours/day for 5 days/week.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Which would you prefer and why.</td>
</tr>
</tbody>
</table>

Source: Chen et al. (2000)

Supyan (2008) describes a research that uses online forums to help extend the ‘zone of proximal development’ as suggested by Vygotsky (1978). The thrust of his research reflects the nature of relationship between technology and social constructivism; and is in accord with Duffy and Cunningham’s (1996) view that technology serves as a tool to expand cognition. This section has discussed in brief the principles that make up constructivism based on a review of the literature.

### METHODOLOGY

The research used a qualitative approach by analyzing selected documents (journal articles) and they are analyzed for mentions of the use of constructivism in context of online learning. The selection criteria for the journal articles are:
1. The journal is cited in the Social Sciences Citation Index (SSCI). Specifically, it is in the category Education and Educational Research. According to the category scope note provided by Thomson Scientific (2007):

Education & Educational Research covers resources on the full spectrum of education, from theoretical to applied, from nursery school to Ph.D. Included in this category are resources on pedagogy and methodology as well as on the history of education, reading, curriculum studies, education policy, and the sociology and economics of education, as well as the use of computers in the classroom.

   a. The number of journals within the SSCI that deals with the use of computers in the classroom is seven. The following is the list of the journals:
   1. British Journal of Educational Technology
   2. Computers and Education
   3. Educational Technology and Society
   4. Innovations in Education and Teaching International
   5. Interactive Learning Environments
   6. Journal of Computer Assisted Learning
   7. Language Learning and Technology

2. The publication date range for both the journal and book selection is work published in a period of ten years, namely from January 1996 to January 2006.

   After a piece of data has been collected, the next step in the process is to code the data. The method used for this question is qualitative content analysis. The category development is primarily deductive application (Mayring, 2000), as sufficient focus has already been provided by the research question itself. Carney’s Ladder of Analytical Abstraction (Carney in Miles & Huberman, 1984) is used to guide the analysis process. The result from the aggregation and reduction of data is then displayed in a matrix display. The procedure for coding and analysis is shown in the Figure 1:
Each data is then examined for the use of constructivism as a theory of learning within the domain of online learning. Table 3 is used to guide the researcher in identifying the learning theories. Once a theory is identified, the location of the supporting evidence is noted in the display for the data.

**Table 3: Characteristics constructivism and associated applications and tools**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Online Applications/Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Learning is understood as interpretative and emergent, and under the control of the learner. Cognition is situated and must be understood in terms of the setting, purposes, tools, and tasks in which the knowledge is to be learned.</td>
<td>• Use of discussion forums and chat (both synchronous and asynchronous techniques)</td>
</tr>
<tr>
<td>• Knowledge is to a large extent a negotiated meaning as cribbed to reality and should be achieved via collaborative group work. (Social Constructivism) or internal construction (Cognitive Constructivism)</td>
<td>• Email transfer amongst learners.</td>
</tr>
<tr>
<td></td>
<td>• Group projects</td>
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<tr>
<td></td>
<td>• Streaming media use</td>
</tr>
<tr>
<td></td>
<td>• Tools for construction of artifacts.</td>
</tr>
<tr>
<td></td>
<td>• Provision for social activities on the net</td>
</tr>
</tbody>
</table>

Source: Adapted from Ally (2004), Berg (2002), Mishra (2001)
The next construct for the analysis is the tools and design. The researcher identified the tools mentioned in each data. Also included are design elements relating to the theory if mentioned by the data. Supporting evidence is provided in the analysis display for each data.

The last step before coming up with the synthesis of the data collected and analyzed was to present the analysis and the raw data itself to a panel of experts. The panel itself acted as inter-raters that went through the analysis and pointed out shortcomings and improvements that could be made. The recommendations made by the panel were taken into account to improve on the final analysis before it was used as the basis for discussion. The panel is made up of a senior lecturer in online CPD, a senior lecturer in instructional design and an associate professor in TESL. The panel was chosen based on their expertise in both qualitative research and areas related to educational technology and its applications in the ESL field.

**FINDINGS AND DISCUSSION**

A total of 36 of the 39 (all except Data 020, 023 and 026) articles that form the data for the research deal with the use constructivism for the design of online learning, and this reflect the dominance of constructivism in recent educational thoughts.

The strongest theme to emerge from the data is the use of constructivism as the theoretical basis to explain and guide online communication (e.g. Data 028, Data 003), apart from its more traditional association with personal construction of knowledge (e.g. Data 001, 005 and 007). Typical applications associated with constructivism are common communicative tools like forums and chats. Eight of the 36 articles (Data 003, 006, 008, 009, 013, 014, 021 and 028) mention the use of social constructivism directly, giving emphasis on the role of user-user interactions for learning.

The role of constructivism in the design of online learning thus focus on two perspectives: the personal and the social. This fact is summed up by Data 002 (Tam 2000: 56):

Another important implication of constructivism for the construction of technology-supported learning environment is that learning is a personal, as well as a social activity. The penetration of technology into the learning process can have profound consequences for how learning takes place socially. On one side, one can see even more individual learning in a student sitting in front of his or her computer. But on the other hand, the technology allows for much more diversified and socially rich learning contexts; peer tutoring via computer; computer networks, e-mail, telecommunications.

Data 001 (Gao et al., 2005) gives a balanced suggestion for the use of both traditional constructivism and social constructivism in one environment. It suggests the use of tools and templates to organize and plan communication within an online environment, which is closer to traditional constructivism and cognitivism. However, it also suggests the use of social networking environment, a virtual “Student Lounge” that allows students to interact socially. More importantly, it suggests the implementation of group collaboration support tools that will enable easier online collaboration between the students. In essence, Data 001 (Gao et al. 2005) captures how constructivism is used for the design of online learning environment.

Similarly, Data 033 (Puntambekar, 2006) also gives a look at both sides of constructivism. It suggests an online “reflective notebook” to support reflective learning, a common constructivist learning strategy. It also suggests the “web board”, a typical discussion forum for discussion and collaborative activities, which are more towards the side of social constructivism.

The data on constructivism also includes the use of constructivism together with other theories of learning. Data 026 (Tsai et al., 2006) for example discusses the use of concept-mapping within a constructivist framework. The use of epistemological tools normally associated with cognitivism, but within a constructivist framework, shows that the tools are not exclusive to only one theory of learning in terms of how they are used.
Data 022 (Howard-Jones & Martin, 2002) discusses the use of embedded questions within hypertext contents. The guiding theory is constructivism; however, the tool used is more in the sphere of content-delivery (hypertext contents), which is more the domain of behaviorism.

Another theory that draws from constructivism is constructionism, which guides the research discussed by Data 016 (Liu, 2003) and 005 (Hazzan, 2004). Constructionism is the belief that people learn better when they construct a ‘public entity’ that is shared with others (Papert & Harel, 1991). The research described in Data 016 (Liu, 2003), for example, requires students to act as multimedia designers in order to present their understanding of a subject via multimedia presentations. Such a requirement could be met easily with better and more sophisticated ‘production’ tools within a CMS. Interestingly, such tools to create and present contents for others to understand would normally be within the behaviorist domain. However, like Data 022 (Howard-Jones & Martin, 2002) discussed in the preceding paragraph, the tools may be behaviorist, but the application and guiding principle are more constructivist.

TOOLS ASSOCIATED WITH CONSTRUCTIVISM

The previous section has established that the roles of constructivism are to guide online communication and collaboration, personal construction of knowledge and constructionism. For communication and collaboration, the tools mentioned or suggested include the following: forums (terms used include online bulletin board, threaded discussion forums, ‘webboard’) (e.g. Data 033), chats (e.g. Data 003), IM (instant messenger) (e.g. Data 028), e-mail and voice mail (e.g. Data 010), online whiteboards (e.g. Data 013), groupware (e.g. Data 009) and audio/video conferencing (e.g. Data 013). Tools for personal construction of knowledge mentioned or suggested by the data include e-portfolios (e.g. Data 012), concept maps (e.g. Data 008) and ‘online notebooks’ (e.g. Data 017). Finally, the tools mentioned for constructionism are content building and publishing tools such as ‘news manager’ (e.g. Data 001), multimedia-enabled web-publishing (e.g. Data 016) and concept maps (e.g. Data 008).

There are several suggestions within the data on how certain tools should be designed. The first suggestion is for a better method to organize online discussion forums as suggested by Data 001, 006, 009, 038 and 039. The suggestions given are geared towards organizing knowledge and information gathered in the forums so they are more structured through the use of epistemological tools such as sentence openers, graphic organizers, workflow templates and annotation tools. This is an example for the need to integrate how the theories are viewed and used in online learning environments. In this case, communicative tools (constructivist) need to be augmented with epistemological tools (cognitivist). Secondly, there are suggestions by two of the articles, Data 013 (Jaervelae & Haekkinen, 2002) and 014 (Kawachi, 2003) for communication channels to be made multimodal instead of relying only on traditionally textual mode of communication.

In summary, the data for analyzed suggested that both sides of constructivism, personal and social, are made use for different purposes. Social constructivism becomes the theoretical basis for guiding online communication and personal constructivism is used for assisting with personal construction of knowledge. The data also shows examples of online tools that are normally associated with these two sides of constructivism.

CONCLUSION

The paper has presented the results for a research that is designed to map out the design of tools normally associated with constructivism in the context of online learning. Based on the data, constructivism is used mainly in the context of communication and collaboration. However, it is also used as the theoretical basis for personal construction of knowledge. This reflects the two sided nature of constructivism: personal and social.
Educators who use constructivism as the guiding theory in their online teaching should look for platforms that provide the tools mentioned in the article. Further investigations could also be carried out on a different selection of data and the results compared to the current data for a more complete picture on the use of constructivism for the design of online learning tools.

REFERENCES


