Europe's Journal of Psychology, Vol 2, No 1 (2006)

# Positive Contributions of Constructivism to Educational Design

**Brian Pagán**
University College Maastricht
Address: Hoenderstraat 13B, 6211 EL Maastricht, The Netherlands
Tel: Weekdays: +31 (0) 61 546 8341; Weekends: +49 (0) 6561 968 619
E-mail: b.pagan@student.unimaas.nl

Thanks:
I would like to thank Pascal van Gerven of the Maastricht University Faculty of Psychology for his support and guidance while writing this paper. He is an excellent instructor and he provided me with valuable insights, which I still apply today.

**Abstract**
This paper contrasts contemporary traditional and constructivist educational models to show that constructivist models have invaluable advantages over and are more effective than more traditional models. Bruner's constructivist theory is discussed, as well as some of its influences, then traditional and constructivist educational models are contrasted point-for-point. The paper then refers to factual examples of successful constructivist education models in practice and suggests methods for using constructivist theory to improve traditionally designed curricula.

---

**Positive Contributions of Constructivism to Educational Design**

A major theme in Bruner's constructivist theory is that learning is an active process, whereby students learn best by constructing new ideas and building new schemas based upon current and past knowledge. The cognitive processes behind this construction draw heavy influence from cultural and social aspects of students' lives, implementation of rewards and punishments, and students' motivation to learn the material. Educational models that utilize constructivist theory consider these influences and attempt to match education systems and curricula to each socio-culturally distinct group of students. They also build programs and train instructors to encourage students to discover principles on their own, using the knowledge they already have to embrace and internalize information (Mos, 2003). Traditional education models, however, do not employ these techniques and are based on outdated educational theory. With socio-cultural diversity being an ever-growing issue for educators and educational system designers, constructivist education models should be more widely used in education.

To support this statement, this paper will first delve into Bruner's constructivist theory. It will then examine traditional and constructivist educational models, listing each one's pros and cons. The paper will contrast real-life examples of constructivist and traditional educational models and discuss ways to improve curricula by using constructivist models.

**Bruner's Constructivist Theory**

The main theme inherent in constructivism is that people learn by constructing new ideas and concepts by interpreting them through comparison with previous knowledge. People attribute meaning to new ideas, and this process represents learning (Hein, 1991). This implies that learning is not about simply being exposed to new information but is an active process whereby learners examine, code, decode, and interpret new concepts and ideas. Learners select and transform information, construct "hypotheses," and rely on cognitive structures to build and refine their schemas (Kever, 2003; Mos, 2003). Broken down, Bruner emphasizes that people interpret their world through the similarities and differences between objects and events. Learners thus compare new ideas to the ones they already have and learn through the similarities and differences they find. A person's socio-cultural background and situation play a highly important role in dictating what sorts of information that person will learn, as well as forming the cognitive processes that person uses to build and use schemas (Kever, 2003).

These principles are central to the discussion of education design improvement later in this paper, and they owe much to ideas proposed by Jean Piaget. While working with children to improve standardized intelligence testing, he modified the standard methods by going further than simply recording a child's answer. Piaget encouraged children to reason about the problem he posed to them. Through this, he discovered that younger children were not "dumber" than older ones, nor were they behind in any way. Younger children simply thought about things in a completely different way than did the older ones, because they have a conception of the world that is distinct from that of older children (Gardner, 1972).

Piaget examined the differences between younger and older children's cognition, and Bruner examines the differences

between that of different cultures. These differences between cultures in this sense arise from necessity. All cultures develop habits, traditions, and activities adapted to their specific needs. These needs stem from environmental and many other factors, and the culture's cognitive development and learning, as well as the relative strengths and weaknesses pertinent to creating and adapting schemas, are adapted specifically to help meet these needs (Glassman, 1996). This is the basic overview of how people's environments and cultures play key roles in their cognitive development, and this paper will now discuss some aspects of Bruner's constructivism that more directly relate to education.

**Constructivist Education Theory**

In addition to recognizing that people from different cultures learn in different ways, Bruner also developed an almost universally applicable instruction theory. The idea behind this theory hold to basic constructivism in that an instructor's main task is to translate information to be learned into a format suited for students' state of understanding. Constructivist instruction theory addresses four highly important aspects of the learning process, (1) students' predisposition towards learning, (2) how to structure knowledge that it can be most readily understood by the learner, (3) the most effective sequence in which to present material, and (4) the nature and pacing of motivational rewards and punishments. Instructors should encourage students to discover the principles of the lesson themselves, primarily by engaging in active dialogue with the instructor and other students (Mos, 2003). Active dialogues is a part of Socratic learning, based on Socrates' premise that discussion engages a student's mind more than listening to lectures. This is because discussion involves active participation on the student's part, instead of passively hearing a lecturer or teacher. Having outlined educational constructivism's key premises, this paper will contrast traditional and constructivist educational models.

**Educational Design Models**

Educational design, is not as straightforward as many believe. It is characterized by a heterogeneity that causes pressures and expectations to vary across the field, but some common issues face all designers. These issues include (1) choosing the most effective teaching, learning, and assessment methods, (2) developing the learning environment, and (3) integrating students' experience into various course elements (Bines, 1992a). Both constructivist and traditional educational models address these issues. The differences, however, lie in the ways they address them, and the next section will contrast these ways.

**Traditional Educational Design Models**

Traditional education seeks to transfer knowledge into students' memory and measures its success through monitoring students' responding to questions in the exact way that they were taught to (Boekaerts, 1996). This subject material reproduction emphasizes exam scores and final answers, rather than the way students arrive at their answers. With the high amount of control afforded traditional education designers, they tend to make use of a content-first design approach. They analyze content and prerequisites first, outline curricula, then generate teaching plans, which they mostly expect instructors to follow closely (Skaalid, 2003). Designers thus choose or design teaching methods based on their efficiency in exposing students to information. For example, lectures, with one instructor lecturing to as many as 400 students, empower a few staff members to distribute information to a large number of students. This method is time efficient; because once a designer creates a curriculum intended for the lecture method, instructors do not need to do extra work or planning on their own. The lecture method is also fiscally efficient, allowing schools to reduce tuition fees, construction costs, and logistics costs. Another example is the smaller-scale classroom-teaching model, where an instructor lectures to between 20 and 30 students and takes time to address individual students' questions and provide a small measure of extra help. While this method is not as cost effective as lecturing to larger audiences, it is more effective in bringing information to students and reinforcing its successful transfer, because instructors can concentrate more on individual students than in a lecture (Bines, 1992a, 1992b). Important to note with regard to both of these instructor-centered education methods is that talking among students is strictly discouraged. Students are traditionally only allowed to speak to the instructor after requesting permission to do so, usually by raising a hand and waiting to be addressed by the instructor (Schuh, 2003). The most interaction students could have under a traditional education system would be recitation of answers in a classroom, prompted by an instructor (Aulls, 2002). Traditional teaching methodology depends on efficient and one-way transfer of information directly from few instructors to many students with minimal or no student discussion.

Such teaching methods encourage learning methods like rote memorization, in which students commit blocks of information to memory. These blocks of information usually include a question and its answer, and students often gather information into lists for easier memorization. Chronological processes (such as the steps of the water cycle) and nomenclature lists (the parts of the brain) are especially suited for this learning method, because one can easily memorize words in sequence and recite them from memory, without having to understand or think about what the words mean. Students can facilitate this memorization process through repetition by verbally repeating words, using flashcards, creating songs to sing repeatedly, etc. (Bines, 1992a, 1992b). These teaching and learning methods are parts of teacher-centered education models and best represent traditional methodologies and education models (Schuh, 2003). Since these methods simply bring information from the instructor to the students, there is not much variation possible in instructors' curricula. Once an educational designer creates a curriculum, instructors simply

deliver it, occasionally adjusting for slower or faster students as the need arises. The high level of control possessed by educational designers in this case allows them to utilize highly automatable assessment methods, like multiple-choice testing. These assessment methods are highly susceptible to automation, because students have little choice in their responses, and variation in student response is quite limited, like the instructor's curricula, as mentioned above. Automation possibilities include computer-assisted grading, with which multiple choice examinations are highly compatible. For example, Scantron is a computer-assisted assessment method that takes full advantage of multiple-choice exams and their compatibility with computer technology. Students mark their responses on a sheet of paper separate from the sheet upon which exam questions are printed. The response sheet has small boxes itemized by numbers and grouped by response possibilities (A, B, C, etc.). During the exam, students color in the small boxes with a pencil. After the exam, the instructor inserts the response sheets into a scanning machine that allows a computer to compare each student's responses with those laid out on an instructor-made answer sheet. This computerized Scantron method saves instructors time and educational institutions money. Again, traditional education methodologies show their appeal to financial planners (Bines, 1992b). Another appeal that traditional methodologies hold is the maintenance of objectivity in assessment. As discussed, traditional education models rely on directly exposing students to information and base assessments on students' responding in exactly the way the instructor(s) taught them (Boekaerts, 1996). These models also favor instructor-centered teaching methods, learning methods, and assessments, representing the first of the three common educational design issues (Schuh, 2003).
The second common issue in educational design is the learning environment. A traditional learning environment, much like the methodologies associated with traditional education models, is instructor-centered. It is common in traditional education settings for instructors to remain distant from their students, especially in lecture settings. Indeed, it is quite difficult for a single lecturer to develop strong relationships with the 400 students enrolled in his course. Even in classroom-teaching settings, instructors only build relationships with his students insofar as he interacts with them. Interaction is the key learning factor, and it is lacking in most classroom-teaching environments (Schuh, 2003). As mentioned, students are discouraged from talking, both amongst themselves and with instructors. This atmosphere severely restricts the interaction level between students and instructors and prevents instructors from building relationships with their students. According to traditional educational designers, such interaction and relationship building is unnecessary to the education process. They maintain that students need only speak to instructors if they have questions or problems assimilating the instructor's presented information, because speaking by students only interrupts instructors' delivery of the material. Such interruptions should only occur when necessary (Bines, 1992a). The learning environments provided by traditional education models are instructor-driven, usually quite formal, promote the retention of distance between students and instructors, and discourage verbal activity on students' parts. Traditional education models barely need to approach the third common educational design issue. Integrating students' experience into various course elements is unnecessary for these educational models. Since traditional education features instructors dispensing knowledge at passive students, the students' level of knowledge is almost irrelevant. Of course, in designing educational curricula, one must ensure that students are capable of comprehending the information, but traditional education does not usually go deeper than that. A typical traditional curriculum will include prerequisites for courses that ensure that all students enrolled in a course are equipped with minimum qualifications to understand the material presented to them. At most, educational planners will develop multiple courses pertaining to the same subject matter, but approaching it at different levels, something along the lines of novice, advanced, and expert (Bines, 1992b). To summarize, traditional educational models utilize instructor-centered methodologies, foster formal, non-interactive learning environments, and retain a low level of integration of students' previous experience.

**Constructivist Educational Design Models**

Constructivist educational models address the same three education issues in completely different ways than traditional models. Constructivist teaching methods are student-centered, not instructor-centered. Where traditional education models emphasize direct transfer of information from instructor to student, constructivist models emphasize less instructor participation and much more student action. In fact, constructivist education is based on students' work, rather than that of instructors (Schuh, 2003). Constructivist classes are made up of small groups, usually comprising between five and 16 students and one instructor. The main idea is that the instructor will help students develop effective course goals, and students work together to accomplish those goals. Such education is built upon discussion among students with only brief and necessary guidance from instructors. This implies that constructivist designers make use of a different approach than traditional educational designers. Also different from traditional models is the constructivist encouragement of student interaction and discussion. The major role that discussion plays results from Socratic learning theory, mentioned above. Aulls refers to such discussion as academic discourse and notes that substantive academic discourse facilitates students' exploration of curriculum topics and material. Such discussion is more than simple, mundane exchanges between instructors and students; it involves students talking about the subject and arriving at their own conclusions (Aulls, 2002). Instructors should not be interested so much in students' responses, but the way students arrive at and defend those responses. In this process, students display elements of scientific reasoning. One some level, all students should recognize problems, formulate hypotheses, construct mental models, research and test their hypotheses, adjust their mental models, and reach conclusions with minimal guidance from instructors (Echevarria, 2003). This high student emphasis level,

however, creates a large unpredictability factor for education designers. Constructivist designers embrace this factor in the design phase by keeping pre-specified content to a minimum and ensuring that instructors encourage students to actively seek their own knowledge sources to deepen and enrich their comprehension of the course material (Skaalid, 2003). What most constructivist designers do is formulate clear course goals, comprehension objectives that students should accomplish by the end of a course. These goals provide a structure and clear “measuring stick” for instructors while empowering students with as much academic freedom as possible. Indeed, this academic freedom most clearly illustrates instructors’ role in constructivist education. The most important of constructivist instructors’ tasks is keeping students on track and guiding them toward the accomplishment of course goals (Echevarria, 2003). Such goals also provide students with contextual frameworks that help them determine from which perspective they approach course material (Boekaerts, 1996). Another difference between traditional and constructivist course design is instructor involvement in the design process. Traditional designers usually perform the process without much interaction between themselves and course instructors. On the other hand, constructivist course designers usually work closely with instructors to ensure smooth design implementation and eliminate any nasty surprises that could hinder the learning process (Skaalid, 2003). In summary, constructivist teaching methodology is student-centered, emphasizes the ways students construct their knowledge, and encourages students to interact with each other as much as possible.

These constructivist teaching methods require high student activity levels, and the corresponding learning methods reflect those levels. The most important constructivist learning method is problem solving. Petraglia maintains that effective constructivist education provides problems that students must handle like real-life problems and that people solve problems better through social cognition rather than alone. Constructivist course goals should provide realistic problems that elicit social cognition, facilitate student application of external knowledge sources, and encourage students to utilize scientific reasoning (Echevarria, 2003; Petraglia, 1998). Scientific reasoning is another learning technique that students employ in constructivist education. As mentioned above, students must formulate and test hypotheses, build and adjust mental models, and form conclusions based on the course material and their own research (Echevarria, 2003). Through this process and lack of excessive interference by instructors, students also develop self-regulation techniques. Common personal attributes associated with good self-regulation are heightened self-efficacy, willingness to participate, commitment, time management, and efficient strategy use (Boekaerts, 1996). In addition, the group work and cooperative discussions in constructivist education allow students to hone their communication and argumentation methods. These methods are more skills that students can use outside the classroom, and they reinforce social cognition (Aulls, 2002). Constructivist learning techniques not only help students learn as efficiently as possible, they also give students the opportunity to practice and perfect skills needed in real life. Since students have so much academic roaming area, constructivist educational designers cannot rely on objective, direct assessments the way traditional ones can. In order to remain flexible to meet the assessment needs of flexible curricula, constructivist instructors must assess their students with subjective, context-based techniques. The most common of these are essays and open-question exams. Instructors usually apply both types of assessment to single individuals, but they can also adapt essays to be worked in small groups. Essays and open questions force students to think outside the constrictions of multiple-choice tests and memorized responses. In keeping with constructivists’ emphasis on students’ argumentation and the ways they arrive at their responses, essays and open questions provide an excellent way for students to communicate their thoughts to instructors that traditional assessments do not provide (Jonassen, 2003). As discussed, constructivist teaching, learning, and assessment methodology all depends on high levels of student activity and is much more subjective than traditional methodologies.

In addressing the second design issue, learning environment, constructivist education models are different from traditional ones in almost every aspect. Traditional learning environments are formal, promote distance retention between students and instructors, and discourage verbal activity by students. Constructivist learning environments, however, are usually more informal, promote close working relationships between students and instructors, and rely on verbal activity by students. As mentioned in the context of traditional learning environments, relationship building requires interaction between students and instructors. In constructivist classrooms, instructors see many aspects of students’ personalities and can easily assess each student’s communication, argumentation, and problem-solving skills. Students, in addition, are exposed to instructors’ group leadership abilities and often senses of humor (Jonassen, 2003; Kever, 2003). These interactions form bonds that are impossible to form in traditional learning environments. These bonds also make students feel more comfortable in their academic environment, which builds confidence and boosts learning performance. This effect also comes from constructivist education’s reliance on and encouragement of student discussion and activity. In traditional education settings, students are punished for expressing themselves at “inappropriate times” and often develop the feeling that their opinions are worthless or unimportant. This feeling can bleed over into real life and later the workplace, resulting in low self-esteem and reluctance to express opinions and views. In a constructivist educational environment, however, students are made to feel that their contributions are important and worthy of being expressed (Schuh, 2003). Constructivist educational models also approach the third common design issue more in-depth than traditional models. The third issue is integrating students’ prior experience into course aspects, and constructivist models’ key factor here is the student-centered approach. Since their curricula and methodologies are not designed around instructors, but students, constructivist educational models are much more flexible and far easier to adapt than traditional ones. Discussion’s

major role puts students in the spotlight and automatically brings previous experience to the fore. Whenever any students have extra knowledge about topics or problems, the constructivist learning environment encourages them to share their experience with the rest of the group, where all groups members can benefit from the knowledge (Mclnerney, Mclnerney, & Marsh, 1997; Schuh, 2003). In a more restrictive sense, prerequisite requirements (like in traditional educational models) installed in courses ensure that all group members can follow discussions and make worthwhile contributions to them. In short, constructivist educational models put forth student-centered methodologies, foster open, challenging learning environments, and highly integrate students' prior experience in the learning process.

**Constructivism at Work**

Now that traditional and constructivist educational models have been explored in detail, this paper will discuss two real-life examples of successfully applied constructivist educational models. The first of these examples is in Brazil, where high rates of school failure were observed in the beginning of the 20th century. The country's mass education system had been implemented at the time, and children from low social strata were thrust into an educational system designed for children of middle to high social strata. The difference between performance rates appeared immediately. Children from lower-class families failed significantly more than those from middle- and upper-class families did. Most psychologists viewed the situation from a social Darwinist standpoint and attributed the difference to biological and genetic factors.

When Helena Antipoff arrived in the country in 1929, she was an instructor for new Brazilian teachers, and she immediately set herself to work upon learning about the cognitive character of Brazilian children. Through her studies, she found that the social and cultural environment in which children grow up heavily influences their cognitive development. Many children that came from rural families failed in urban schools, and so did many that came from impoverished and/or abusive households. She also determined that standard IQ tests were not adequate measures of comprehension and invention implied by their definition. Using this information and her position at the Teacher's Training College, she played a key role in adjusting schools to be more accommodating to lower-class children by rescheduling class times to adjust them to the children's socio-cultural lives, educating teachers in improved instructional techniques, and restructuring the way IQ tests were used to separate children in schools. Not all of her proposals were implemented, but those that were brought Brazilian schools out of a period of mass failures and into one of maintained high rates of grade retention by the early thirties. Antipoff saw the most important problem as being that teachers thought children's low IQ test scores and high failure rates meant that they were less intelligent, when the case was simply that the tests and urban school settings were so strange for the children that they could not effectively cope with them (Campos, 2001).

Currently, many US institutions are replacing the traditional classroom-teaching style of education with the constructivist problem-based learning style (PBL), both in higher and professional education. Professional educators prefer the PBL system, because it facilitates student autonomy and easier curriculum negotiation. Furthermore, when PBL is combined with small group work, it includes communication and collaborative skills that are missing in traditional professional education (Bines, 1992a)

**Practical Application**

This paper has shown that constructivist education models have already been successfully implemented, now it will explore some ways to convert traditional education systems into effective, constructivist ones. The first area of focus for improvement will be the traditional design process. Most traditional designers base their final curricula on available content material. This design strategy is constrictive for instructors and students and does not provide enough flexibility or adaptability. To remedy this, education designers should create less restrictive course goals and not focus excessively on course material. This method, as already mentioned briefly, both encourages students to seek out their own materials and provides enhanced flexibility for instructors to adapt curricula to different student groups and academic situations (Skaalid, 2003). Another common design error that traditional designers make is material oversimplification. The idea behind this simplification is to make the material easier to teach and to learn, but it actually strips away most of the material that should stimulate critical thinking in students. Instead of simplifying material, education designers should challenge instructors to devise more efficient discussion methods. Efficient discussion allows students to reach many conclusions by themselves that they normally would not (Jonassen, 2003).

Other ways to improve traditional education systems lie in the way instructors execute designers' course plans. This paper has already mentioned that instructors should be closely involved with the course design process, but faulty execution can ruin even the best plans. For example, instructors and designers should perform progress-monitoring tasks continuously throughout the project cycle, not only once in the beginning. This constant monitoring provides up-to-date feedback and allows designers and instructors to modify education systems and correct problems before they become too severe. Traditional instructors place too much emphasis on design goals or objectives when implementing new education models, where objectives are not limits but heuristics for guiding operational performance. Limiting students according to course objectives defeats the purpose of constructivist educational models. Another point on flexibility is to allow for additional goals and/or objectives to arise during a course. Instructors that follow course goals to the letter often reject additional course goals, and this an unnecessary limit for

students. Another consideration in improving existing programs is that education designers (in concert with instructors) must tailor implementation strategies to the course material and goals. To avoid going wrong in this regard, designers should utilize rapid prototype techniques or conduct small-scale experiments to determine a program's compatibility with its material (Skaalid, 2003).

Still, an institution must consider some issues before converting to a constructivist education system. One of the possibly negative consequences of such conversion could be the loss of objectivity and formality that accompany traditional education methods. As previously discussed, constructivist assessment methods are highly subjective, whereas automated traditional assessments are reasonably objective in comparison. Another negative consideration is the financial one. It costs more to have many small classrooms that it does to have a few large lecture halls. Smaller class sizes and groups mean either lower admissions or hiring more instructors. To be the most effective, students should have ready access to resources like libraries, the internet, e-mail, etc. The advantage of these expenditures is naturally better education, but if an institution cannot afford such adjustments, then it is unfeasible to attempt them.

**Conclusion**

As above sections have shown, constructivist educational models have a real and quite powerful impact upon education and learning in general. Failing to apply the principles inherent in such models can cause such problems as high failure rates among students and mistaken low-ability assessments, and it can waste valuable learning potential. To avoid these problems, educational designers, working closely with instructors, should tailor curricula to the target students in keeping with socio-cultural environment and other cognitive influences. Educators, in turn, should employ sound educational methods that promote Socratic learning and encourage students to "fill in the blanks" themselves. This paper has also shown the positive consequences of Antipoff's application of constructivist principles in Brazil during the early 20th century. Furthermore, it has also put forth recommendations and considerations regarding the improvement of existing educational systems and transforming them into more efficient, effective, and constructivist ones. Once constructivist principles are globally applied to education, the world's students will learn more efficiently and effectively. Who knows what we could accomplish then?

**References**

Aulls, M. W. (2002). The Contributions of Co-Occurring Forms of Classroom Discourse and Academic Activities to Curriculum Events and Instruction. Journal of Educational Psychology, 94(3), 520–538.

Bines, H. (1992a). Course Delivery and Assessment. In Developing Professional Education (pp. 57-92). Oxford: SRHE and Open University Press.

Bines, H. (1992b). Issues in Course Design. In Developing Professional Education (pp. 11-56). Oxford: SRHE and Open University Press.

Boekaerts, M. (1996). Self-regulated Learning at the Junction of Cognition and Motivation. European Psychologist, 1(2), 100-112.

Campos, R. H. d. F. (2001). Helena Antipoff (1892-1974): A Synthesis of Swiss and Soviet Psychology in the Context of Brazilian Education. History of Psychology, 4(2), 133-158.

Echevarria, M. (2003). Anomalies as a Catalyst for Middle School Students' Knowledge: Construction and Scientific Reasoning During Science Inquiry. Journal of Educational Psychology, 95(2), 357-374.

Gardner, H. (1972). Piaget. In The Quest for Mind: Piaget, Lévi-Strauss, and the Structuralist Movement (pp. 51-110). London: Coventure.

Glassman, M. (1996). The Argument for Constructivism. American Psychologist, 51(3), 264-269.

Hein, G. E. (1991, 15-22 October). Constructivist Learning Theory. Paper presented at the CECA (International Committee of Museum Educators) Conference, Jerusalem Israel.

Jonassen, D. (2003). Designing Constructivist Learning Environments (CLEs). Retrieved January 28, 2004, from http://tiger.coe.missouri.edu/~jonassen/courses/CLE/

Kever, S. (2003, Mon Mar 3 6:59:24 US/Pacific 2003). Constructivist Classroom: An Internet Hotlist on Constructivist Class. Retrieved 22 January, 2004, from http://www.kn.pacbell.com/wired/fil/pages/listconstrucsa1.html

Mclnerney, V., Mclnerney, D. M., & Marsh, H. W. (1997). Effects of Metacognitive Strategy Training Within a Cooperative Group Learning Context on Computer Achievement and Anxiety: An Aptitude-Treatment Interaction Study. Journal of Educational Psychology, 89(4), 686-695.

Mos, L. (2003). Jerome Bruner: Language, Culture, Self. Canadian Psychology, 44(1), 77-83.

Petraglia, J. (1998). The Real World on a Short Leash: The (Mis)Application of Constructivism to the Design of Educational Technology. Educational Technology Research and Development, 46(3), 53-65.

Schuh, K. L. (2003). Knowledge Construction in the Learner-Centered Classroom. Journal of Educational Psychology, 95(2), 426-442.

Skaalid, B. (2003). Application of Constructivist Principles to the Practice of Instructional Technology. Retrieved January 28, 2004, from http://www.usask.ca/education/coursework/802papers/Skaalid/application.html