EXAMINING THE INTERPLAY BETWEEN CONSTRUCTIVISM AND DIFFERENT LEARNING STYLES

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Constructivism is a philosophy that supports student construction of knowledge. Since students uniquely construct their knowledge, instructional strategies that support constructivist philosophies naturally advocate student understanding. Instructional trends in the mathematics and statistics education communities support the active-learning orientation of constructivist philosophy. I posit that, while not the only philosophy of teaching and learning, constructivism is one of the best such philosophies. One question remains: "How do instructional strategies that support student knowledge construction address the needs of all students?" I first examine learning styles in general, then enumerate a collection of instructional strategies that support constructivism, and conclude with an analysis of how instructional strategies that support constructivism address the needs of the learning styles previously examined.

INTRODUCTION

In order to frame any discussion on the interplay between constructivism and different learning styles, it is first necessary to have a common understanding of constructivism itself. The interplay portion of this paper is based on the following definition of constructivism:

> A theory of learning that allows students to develop and construct their own understanding of the material based upon their own knowledge and beliefs and experiences in concert with new knowledge presented in the classroom. (Miller, 2000, p. 92)

Another distinction that must be made is that between epistemology and learning style. When examining epistemological questions, researchers ask, "what is the nature of the relationship between the knower or would-be knower and what can be known" (Guba & Lincoln, 1994, p. 108). When examining learning styles, researchers talk about the "characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Sims & Sims, 1995, p. xii). Here I will concentrate on learning styles, which will be discussed in the next section of this paper.

One thing that should be kept in mind while reading this paper is that the context for the discussion of the interplay between constructivism and different learning styles is the teaching and learning of introductory statistics. The statistics education community has almost come to a consensus on teaching the introductory statistics course (Moore & Cobb, 2000). Part of this consensus addresses the process by which students should learn statistics. According to Moore and Cobb:

> What statistics and other quantitative subjects offer, and traditional mathematics courses often do not, is more experience with the process of searching for patterns at a low level of abstraction before formulating a more abstract statement and then assessing its validity. (p. 622)

Moore and Cobb add, "[that] when students experience [this] process, as opposed to just its products, the barriers between learning and research are lowered in healthy ways" (p. 622). Thus, statistics becomes a tangible discipline to its learners, a prime candidate for instructional strategies that support knowledge construction.

I begin this paper with a discussion on how various instructional strategies support constructivist theory. First, learning styles are addressed and then funneled into three particular styles for discussion. Next, several instructional strategies that are candidates for supporting constructivist theory are enumerated. This is followed by my actual examination of the interplay between constructivism and different learning styles. Finally, I conclude by posing ideas for consideration of a further discussion on this interplay.

A VARIETY OF LEARNING STYLES

To assess a student's learning style, one might choose to administer a learning style inventory. Learning style inventories can be divided into three categories (Hickcox, 1995): instructional and environmental preference (e.g., the Dunn, Dunn, & Price Learning Style Inventory); information processing preference (e.g., the Kolb Learning Style Inventory); and personality related preference (e.g., the Myers-Briggs Type Indicator). No matter what approach is used to inventory the learning styles of a group of students, one thing is certain: there will be at least as many learning styles in the classroom as there are students. Thus, it is important to find pedagogical techniques that encourage students of all learning styles to learn.

Many researchers have classified learning styles into categories. The underlying paradigm of the researcher impacts any classification that is done. In the final chapter of their edited book, Sims and Sims (1995) state that "there are many ways of describing and assessing learning styles—that is, the typical ways a person behaves, feels, and processes information in learning situations. The [learning style] models…described similar phenomena from different vantage points" (p. 194). In categorizing learning styles, I could focus on learning behavior. Three levels of learning behavior are: cognitive personality style - the individual's approach to adapting and assimilating information; information processing style - the intellectual procedures used by individuals in assimilating information; and instructional preference - the individual's preference for learning environments and activities (Anderson, 1995, p. 69). Alternatively, I could use culture, race, ethnicity, class, and/or gender to categorize learning styles. I could also determine whether student learning is field dependent or field independent in nature (Anderson, 1995). Again, the way that I choose to categorize learning styles is dependent upon my own underlying learning theory paradigm.

No matter how anyone categorizes learning styles, it is what we do with new information once it reaches our brains that defines our unique learning style—"it is the way in which each person absorbs and retains information and skills; regardless of how that process is described, it is dramatically different for each person" (Sims & Sims, 1995, p. 194). Because of this, any learning styles that I spell out could never be an all-inclusive list. I do feel confident stating, however, that learners obtain information through audio, visual, and/or kinesthetic means. In fact, students can usually identify that they learn best through one (or more) of hearing, seeing, and/or doing. No matter how others have defined learning styles, by funneling my discussion of learning styles into these three ways of obtaining information, I can concentrate my efforts on how these three learning styles interact with different instructional strategies to allow students to learn by constructing their knowledge.

INSTRUCTIONAL STRATEGIES THAT SUPPORT CONSTRUCTIVISM

Miller (2000) enumerated several instructional strategies that support constructivist philosophy and can be used in the statistics classroom. Table 1 includes these techniques, as well as citations for the original sources from which they were gleaned.

Table 1
Instructional Techniques that Support Constructivist Philosophy

Instructional Technique	Citation
Topic introduction through activities and simulations	Garfield (1995); Garfield & Ahlgren (1988)
Demonstrations based on class-generated data	Cobb (1992)
Group problem solving and discussions	Cobb (1992); Garfield (1995)
Group or individual projects	Cobb (1992); Garfield (1995)
Written and oral presentations	Cobb (1992); Garfield (1995)
Activity-based courses	Garfield (1995)
Student predictions of outcomes prior to activity	Garfield (1995)
Allowing students to have multiple representations, think time and wait time, and interaction time with peers	Hatano (1996); Tobin & Tippins (1993)

Miller (2000) listed the following results of the employment of some of the instructional strategies listed in Table 1:

1. More time spent on developing understanding increases student ability to transfer knowledge across domains (Hiebert & Carpenter, 1992).
2. Benefits of using small groups in class include increased productivity, improved attitudes, increased understanding, and (sometimes) increased achievement (Garfield, 1995; Good, Mulryan, & McCaslin, 1992)
3. Open-ended problems allow more student learning than do goal-specific problems with one correct answer (Brooks & Brooks, 1993; Garfield, 1995)
4. Active learning provides a sense of realism, engages students in the learning process, and helps to make some concepts concrete (Garfield, 1995; Gnanadesikan, Scheaffer, Watkins, & Witmer, 1997)

Even with the results reported above, because "the constructivist model is descriptive, not prescriptive" (Airasian & Walsh, 1997, p. 444), it is difficult to define instructional strategies that *always* support constructivism. I propose that *any* instructional strategy has the potential for supporting student construction of knowledge. With this in mind, instead of delving into the specifics of how these instructional strategies might potentially support constructivism, I choose now to use the least-likely method—the lecture—as an example of how any instructional strategy can potentially support student construction of knowledge.

Lecture can indeed encourage students to construct their own knowledge, if the lecturer has an understanding of constructivist learning theory in mind. For those who identify as audio learners, perhaps hearing the material starts the information processing through their brains. Similarly, the visual learners can see both the speaker and the written text, and the kinesthetic learners can write the incoming information down in the form of notes. While not the strongest example of an instructional strategy that supports knowledge construction, even lecture can help some students construct their knowledge about statistics.

Consider an add-on technique that can be used with lecture: one aspect of a teacher's lecture might be to leave her/his students with an end-of-period question, a hook to inspire the students to think about statistics outside of the classroom. What student can leave an unanswered question burning in her/his mind? Learners, be they audio, visual, or kinesthetic, cannot avoid thinking on some level (conscious or subconscious) about this unanswered question. Thus, learning is happening for each student outside of the classroom. These students can then seek the answer(s) to the question in any way that fits with their individual learning styles. When these students return to the classroom for the next lecture, they will have a different understanding of the statistical concept (or, perhaps, statistics in general) than they had when they left the classroom after the previous lecture.

The determining factor as to whether or not an instructional strategy supports constructivist theory is the pedagogical paradigm of the teacher. This issue is addressed in the examination of the interplay between constructivism and different learning styles in the next section of this paper.

THE INTERPLAY BETWEEN CONSTRUCTIVISM AND DIFFERENT LEARNING STYLES

In previous work, I made a key assumption about student learning: "all knowledge and understanding about statistics is constructed" (Miller, 2000, p. 12). With this in mind, all instructional strategies must promote knowledge construction to some degree. I found, in that same work, that I could not dichotomize instructional strategies into whether or not they supported constructivist theory, but I could attempt to identify the extent to which these strategies supported constructivist theory. Similarly, it is difficult to identify the interplay between constructivism and different learning styles, because I must now investigate how any combination of instructional strategies (which all support knowledge construction to some degree) is utilized to teach students of all learning styles.

No matter what a student's learning style is, instructional strategies that support knowledge construction enhance a student's learning and understanding (Miller, 2000). Since all instructional strategies support knowledge construction to some degree, it is up to the teacher to decide which instructional strategies to employ. I put forward that teachers who come from a

constructivist paradigm are better equipped to select a battery of instructional strategies that encourage knowledge construction than teachers whose teaching paradigms are not grounded in constructivist theory. This is because one of the important aspects of a teacher who comes from a constructivist paradigm is that s/he appreciates (and embraces) the prior knowledge, beliefs, and experiences that students bring into the classroom with them. Because of this appreciation, "with constructivism, there is an emphasis on students interacting with the new ideas and experiences in learning environments fostered by the teacher" (Miller, 2000, p. 37). While other theories of learning do not view the learner as central to her/his education, constructivism supports "the central role of the learner in his or her own education" (Brooks & Brooks, 1999, p. 18).

The central issue of the constructivist approach to teaching and learning is that "learners control their learning" (Brooks & Brooks, 1999, p. 21). Because of this, it matters neither what the student's learning style is nor how we choose to categorize her/his learning style. What matters is that we foster environments in which *all* learners can and do learn. Such environments seek "the right balance between the activities of constructing and receiving knowledge, given that not all aspects of a subject can or should be taught in the same way" (Airasian & Walsh, 1997, p. 447).

It is through her/his role as facilitator/mediator of learning that a teacher provides appropriate tools to students to encourage each student's individual learning and understanding of statistics. These tools are provided through the particular collection of instructional strategies that the teacher uses in her/his classroom. Different topics in the introductory statistics course lend themselves to various methods of instruction. Through experience, a teacher can achieve the ability to determine how to help all students in her/his introductory statistics course construct their new knowledge and understanding of the discipline of statistics. This is by no means a one-time determination, but rather a process of continually adapting her/his teaching for the particular group of students for the particular concepts that are being taught.

Teaching is, we would all agree, a complicated process; teaching in line with constructivist theory is even more complicated than with more traditional learning theories. This is because we as teachers need to think about our students as learners who process information on an individual basis, not as a group of people to whom we "give" information that is "received" unaltered and precisely as we intended it to be received. Despite the inherent difficulties of continuously tailoring their teaching, teachers who come from a constructivist paradigm are naturally in a good position to teach students of all learning styles.

DISCUSSION

This paper attempts to pursue a question that developed during earlier research. In previous work (Miller, 2000), I found that "there is much research about constructivism and the use of constructivist theory in the classroom" (p. 261), but I could not find literature that addresses "how to identify instructional strategies as supporting (or not supporting) constructivist theory" (p. 261). While doing my literature review for this paper, I found that this hole in the literature remains. Thus, this paper can only begin the discussion on the interplay between constructivism and different learning styles.

This issue is far more complicated than can be addressed in a paper of this size. While researching the literature and considering the ideas for this paper, I have found that even funneling learning into three styles (audio, visual, and kinesthetic) falls short of what is necessary to examine the interplay between constructivism and these learning styles. I come back again to my assumption that all knowledge and understanding about statistics is constructed. Thus, it matters not how researchers define learning styles. What matters is that the teacher comes from a paradigm that supports knowledge construction. Since our pedagogical paradigms define our teaching, teachers who come from a constructivist paradigm will naturally use multiple instructional strategies to promote student construction of knowledge and thus enhance the learning of all students.

I feel that, as I reach the end of this paper, I have not come up with anything new. I invite those who read this paper and are interested in continuing this discussion with me to contact me. There is much work to be done out there—this is but the tip of the proverbial iceberg.

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