PLANNING FOR LEARNING: LIMITATIONS OF TEACHING ALGORITHMS

Andrew P. Johnson, Ph.D.
Minnesota State University, Mankato
https://rss.com/podcasts/drandy

This is an excerpt from my book, ***Essential Learning theories and their applications*****.** Lanham, MD: Rowman and Littlefield (Johnson, 2019).

This chapter describes lesson planning from two different perspectives: algorithmic and heuristic.

Algorithms and Heuristics

An algorithm is formula for solving problems. Here you follow a step-by-step set of procedures in order to achieve a specific outcome. In other words, by correctly following a prescribed set of steps in the specified order, you will be led to a predefined solution. Algorithms are useful in mathematics and computer science for calculation, data processing, and automatic reasoning.

A heuristic is a general set of principles that are flexibly applied as needed to solve a problem or get a preferred result. Applying these principles will not lead you to a specific outcome; however, they can be used to achieve a desired outcome.

Heuristic strategies are useful for the types of real-life problems for which there is not always a specific answer. Examples of these include problems such as, *"How can I keep students engaged in my social studies class?"* Or, *"How to can I get my students motivated to read during the summer?"* Or, *"What can I do to effectively address this academic standard?"* These are all classroom problems for which algorithms would not work. In fact, algorithms have very limited uses outside of controlled contexts such as mathematics and computer science. Most of the problems encountered in the real world require a heuristic solution.

An Algorithm Applied to Teaching

Given the limitation of algorithms in real world settings, it is surprising that an algorithmic solution is often deemed as being appropriate for a common real world problem related to teaching and learning. This problem is: *"What is the best way to teach this lesson?"* An algorithmic view of teaching and learning would posit that an algorithm, in the form of a very specific set of step-by-step procedures, uniformly applied to the process of teaching, is the best solution this common problem. The algorithm here is manifest in the form of a very, specific lesson plan format (see below) or an instructional model.

The teaching algorithm has had slight variations over time with different titles such as: programmed instruction, criterion referenced instruction (CRI), conditions of learning, mastery learning, mastery teaching, strategic instruction, learning strategies, direct instruction, explicit direct instruction, supported instruction, and the framework for teaching. All of these teaching algorithms share a common assumption: If the algorithm is followed explicitly, the teacher can be assured that students will learn. From this perspective, the solution for any learning problem is simple: follow the algorithm.

Variations on an Algorithmic Theme

The Madeline Hunter lesson plan format was popular in the late 1970's and 1980's and is still being used today (Hunter, 1982; Hunter, 2004). Hunter's original purpose was to provide a platform that would enable educators to have conversations about effective teaching. However, it quickly moved away from being a conversational platform to becoming a teaching algorithm. Schools and teacher preparation programs began to use the seven elements described in Hunter's model of instruction to observe and evaluate teachers. These seven elements became known as the Hunter Lesson Plan. They are described below:

1. Anticipatory set. The teacher introduces students to the lesson. It should be used to grab students' attention, to stimulate curiosity, or to get them reading for learning.

2. Purpose. The teacher explains the purpose of the lesson to students. This is also used to provide an overview of what is to be learned. Often, teachers describe what students should be able to do after the lesson.

3. Input and modeling. The teacher provides the information that students need to know to understand the lesson concept or skill. The teacher demonstrates what is to be learned.

4. Check for understanding. The teacher checks to see if students understand what was presented in the Input. The is called formative assessment. Questions are often used here as a probe to check for understanding.

5. Guided practice. The teacher leads the students through a highly structured activity that enables students to practice their new learning with the guidance and support of the teacher.

6. Independent practice. Students are released to practice their leaning on their own. This is often homework or seatwork assignments given to practice the material or skill without teacher supervision.

7. Closure. Here, the teacher brings the lesson to some kind of conclusion. The teacher might review the major ideas, use a graphic organizer to organize content, reinforce important concepts, or ask some clarifying questions. The closure should help bring things together in students' mind.

Limitations of a Teaching Algorithm

If used as a general guide or scaffold, the Hunter lesson plan format might be helpful for beginning *teachers* if it is flexibly applied and used in limited situations. However, once it becomes an algorithm it tends to inhibit more than enhance good teaching. Some of the limitations include the following:

1. The Hunter lesson plan involves a form of direct instruction. While direct instruction is effective for learning low level facts and skills, it is not very effective for higher level learning (Eppley & Dudley-Marling, 2018).

2. While there is research to support the idea that planning enhances teacher effectiveness and student learning (Freiberg & Driscoll, 1992; Stringfield & Teddlie, 1991; Walberg, 1991); little evidence can be found to support one type of lesson plan format over another. That is, there is little if any research comparing the Hunter model to more heuristic lesson planning formats.

3. The Hunter lesson plan leads to the false assumption that there is a standardized teaching process. Trying to standardize the teaching process does not enable individual teachers to utilize their unique strengths. Neither does it recognize the diversity of learners with a wide range of abilities, interests, and learning styles.

4. While individual elements of this format might be necessary in certain teaching situations, all the elements are not necessary in every lesson. That is, effective learning experiences can be created without many of these elements, and ineffective learning experiences can occur despite the inclusion of all of these elements.

Two Basic Lesson Plan Formats

Teaching is a complex endeavor. It is made infinitely more so by external demands that would have teachers try to shoehorn their lesson plans to fit into an overly cumbersome, standardized lesson plan format. Also, there is no singular type of lesson plan that works best for all situations. Instead, different kinds of lessons call for different kinds of lesson plan formats (Johnson, 2017). And, if teachers understand some of the basic principles of human learning described in this book, the overly-complex teaching recipes or cumbersome lesson formats do not need to be used. Below are described two basic lesson plan forms: a schema-building lesson plan and a skills lesson plan. These are heuristic solutions to the problem of planning effective lessons.

A Basic Schema-Building Lesson

The schema-building lesson plan is designed to enable the assimilation and accommodation of information into students' existing and developing schemata. The three basic elements necessary to design this type of lesson are (a) a purpose statement, (b) input, and (c) an activity

1. Purpose statement. In designing a learning experience, you should begin with a specific idea of what it is you wish to teach. A purpose statement is used here. This is a single statement identifying what you want student to learn or know. Behavioral terms or a behavioral objective are not used because true learning cannot be observed (see below). The following is an example of a purpose statement: *Students will learn about amphibians*. Everything that follows the purpose statement in a lesson plan (input and activities) should support it. Anything that does not support the purpose statement should be not be included in the lesson.

2. Input. Input is the heart of the schema-building lesson plan. Here you present the specific information that students need in order to meet the lesson purpose. Any discussion questions used as part of the lesson should also be included here. This should be presented in an organized fashion using language and terms that students will understand. It is recommended that your plan use list or outline form with short, abbreviated sentences. This will allow you to quickly see the structure and sequence of the lesson as you are planning. This will also enable you to teach from the lesson plan without reading directly from it.

3. Independent practice. Independent practice is an activity that enables students to manipulate or interact with the information provided in the input. This could include activities for students to practice their learning, extend their learning, or apply things that they have learned.

A Basic Skills Lesson Plan

Teaching a skill of any kind incorporates four components that are incorporated into a slightly different lesson plan form: (a) purpose statement, (b) direct instruction and modeling, (c) guided practice, and (d) independent practice. (Johnson, 2000). Each of these components is described below.

1. Purpose Statement. This is a one-sentence statement that identifies the skill that you want students to learn about or be able to do.

2. Input. The input is used to tell students exactly what they need to know in order to perform the skill. Here, you provide explicit instruction related to how the skill might be used and the specific steps. You should also demonstrate and model it by thinking aloud while going through each step.

3. Guided practice. Guided practice, sometimes referred to as scaffolded instruction, is at the heart of teaching a skill of any kind (Rosenshine, 2012). The goal here is to provide the support necessary for students to use the skill independently. Here, you take all students through each step of the skill several times, each time providing less scaffolding (see Chapter 9).

4. Independent practice. This is an activity designed to enable students to independently practice or reinforce the skill they have just learned. This may include an in-class activity or homework. If the skills lesson has been taught effectively, students should be able to complete this with 95% -100% success ratio (Brophy, 1986).

• **Regular Practice, Review, and Integration**. This element is not part of the skills lesson plan; however, it should be understood that mastery of any skill never occurs with a single lesson or exposure. When learning any kind of skill, students need to re-visit and review it many times for it to become part of their repertoire. Regular practice allows for efficiency and automaticity.

Objectives and Assessment

Two final areas to consider when planning for instruction are behavioral objectives and assessment.

Behavioral Objectives and Purpose Statements

Behavioral learning theory describes learning as a change in behavior that occurs as a result of instruction or experience. Behavioral objectives are in alignment with this theory (see Chapter 6). A behavioral objective is a single-sentence statement describing the desired outcome for the lesson in terms of a specific behavior. In other words, if the lesson were successful, you would expect to see that behavior.

Neurological, cognitive, and transformative learning theories all describe learning as internal events. It is a change in neural pathways, cognitive structures, or consciousness. From these perspectives, learning cannot be directly observed; hence, a behavioral objective would not be appropriate. Instead, from these theoretical perspectives, a purpose statement is appropriate.

To compare behavioral objectives and purpose statements, examples of both are included here:

Behavioral objective: Students will correctly identify and describe the essential elements of classical conditioning.

Purpose statement: Students will learn about classical conditioning.

Behavioral objective: Students will create a time line to show seven important events in the origin of Blue Earth County.

Purpose statement: Students will learn about the origin of Blue Earth County.

Behavioral objective: Students will demonstrate their knowledge of amphibians by successfully completing the amphibian worksheet.

Purpose statement: Students will learn about amphibians.

Behavioral objective: Students will be able to correctly identify the verbs used in their daily writing sample.

Purpose statement: Students will learn about verbs.

Limitations of Behavioral Objectives

Below are *four* reasons to support the use of purpose statements over behavioral objectives:

1. Real learning is not defined by or confined to a behavioral objective. Deep, meaningful learning often goes far beyond the behavioral objective. If you define what must be,

you run the risk of limiting what might be. Thus, behavioral objectives can stymie rather than enhance real learning.

2. Learning is not uniform. A major tenet of many of the learning theories described in this book is that we construct new knowledge based on our current knowledge. Thus, during any given lesson, each learner is constructing a slightly different view of the new concept or topic based on his or her background knowledge. To assume uniformity limits learning. Thus, while we provide the same input, the levels and types of learning is going to be a bit different for each student. In other words, each student will take something different from the lesson.

3. Behavioral objectives focus on standardization. Humans are not standardized entities. In any normal population, scores will be distributed along a bell-shaped curve. If the same behavioral objective, input, and assignment are used for all students in an average classroom, 68% of the students might be adequately challenged. However, 16% will be over-challenged, feel frustrated, and will fail. Another 16% will be under-challenged and feel frustrated and bored.

4. Behavioral objectives promote the fallacy of mastery. Learning is never complete with a single encounter with any skill or concept. We need to retouch, revisit, and review concepts and skills many times at successively higher levels in a variety of contexts for mastery to occur.

Assessment is Optional

Many approaches to lesson planning require a `plan for assessment. This is a description of how you will determine if the behavioral objective or purpose statement has been met. However, teaching is always more effective if the focus is on students' learning rather than the assessment of learning. Thus, not every lesson should include a plan for assessment.

If you do not include a plan for assessment, how do you know if learning has occurred? A more appropriate question to ask is, *"How do you know if teaching has occurred?"* In other words, if the focus is on effective teaching using strategies that are aligned with research-based theory, most of the learning will take care of itself.

While is not appropriate to include a plan for assessment with every lesson, there are times and places when it is appropriate to assess and describe students' learning. Remember, learning is seldom complete after a single encounter with any skill or concept. Instead, students need to review, re-engage, reflect, practice, and apply new skills and concepts before they are fully learned.

Therefore, a more effective approach to assessment is to collect small bits of meaningful data at specific places in the curriculum to see if and to what degree learning is taking place. In this way, assessment is very much like collecting soils samples: You do not dig up the entire lawn to see what kind of soil you have. Instead, you take small samples from different parts of the lawn.

Reflection

Reflection is not a formal part of a lesson plan, but it is a critical element in being and becoming a master teacher (Noormohammid, 2014; Zeichner & Liston, 2014). As such, it is an essential part of any lesson. Reflection occurs during the teaching episode in what is called "formative assessment." It also occurs after the teaching episode in what is called "summative assessment." Reflective thinking occurs on three levels. Each level is described here.

Level 1: Teaching effectiveness. Effective teachers reflect to assess learning outcomes (Sadker, Sadker, & Zittleman, 2008). They examine the teaching episode in order identify those things that worked well and those things that could have been done differently.

Level 2: Research, research-based practices, or research-based theories. Decisions made by expert teachers are grounded in established theory and research-based practices (Porter, Youngs, & Odden, 2001; Stanovich & Stanovich, 2003). Effective teachers pause to examine their teaching practice to see if what they are doing aligns with a body of research and research-based theory related to teaching and learning. Of course, it is hard to reflect at this level if you have nothing upon which to reflect. Thus, you can see the importance of having sufficient knowledge in each of the four areas described in Chapter 1.

Level 3: Values and philosophy. Teaching at the highest level requires that teachers pause to consider if what they are doing is in harmony with their personal and professional values and their philosophy (Dewey, 1934).

Internalization

If you are a beginning teacher, know that whatever lesson plan format you are currently using will look much different than the format you will use eventually use after a few years of experience. This is because you have internalized the structure. This is the Vygotskian idea that thinking moves from outside to in.

References

Dunn, S. (1991). Second-generation research on teachers' planning, intentions, and routines. In H. Waxman & H. Walberg (Eds.), *Effective teaching: Current research* (pp. 183–201). Berkeley, CA: McCutchan.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought process. In M. Wittrock (Ed.). *Handbook of research on teaching* (3rd ed.) (pp. 255–296). New York: Macmillan.

Eppley, K., & Dudley-Marling, C. (2018). Does direction instruction work?: A critical assessment of direct instruction research and its theoretical perspective. *Journal of Curriculum and Pedagogy, 14*, 1-20.

Freiberg, H. J., & Driscoll, A. (1992). *Universal teaching strategies.* Needham Heights, MA: Allyn and Bacon.

Hunter, M. (1982). Mastery teaching. Thousand Oaks, CA: Corwin Press.

Hunter, R. (2004) Madeline Hunter's Mastery Teaching: Increasing Instructional Effectiveness in Elementary and Secondary Schools (2nd ed.) Thousand Oaks, CA: Corwin Press.

Johnson, A. (2000). *Up and out: Using creative and critical thinking skills to enhance learning.* Boston, MA: Allyn and Bacon.

Johnson, A. (2017). *Teaching strategies for all teachers*. Lanham, MD: Rowman and Littlefield.

Noormohammadi, S. (2014). Teacher reflection and its relation to teach efficacy and autonomy (2014). *Procedia – Social and Behavioral Sciences,* 98 (6), 1380-1389.

Rosenshine, B. (2012). Principles of instruction: Research-Based strategies that all teachers should know. *American Educator, 36,* 12-9.

Stringfield, S., & Teddlie, C. (1991). Schools as affecters of teacher effects. In H. Waxman & H. Walberg (Eds.), *Effective teaching: Current research* (pp. 161–179). Berkeley, CA: McCutchan.

Walberg, J. J. (1991). Productive teaching and instruction: Assessing the knowledge base. In H. Waxman & H. Walberg (Eds.), *Effective teaching: Current research* (pp. 33–62). Berkeley, CA.

Zeichner, K.M., & Liston, D.P. (2014). *Reflective teaching: An introduction* (2nd ed). New York, NY: Routledge.