The Differentiated Visual Tools Model

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A host of factors account for students having difficulty effectively processing secondary expository texts including text complexity (e.g., structure and unfamiliar vocabulary), text density, increased abstractness, heavy demands for large amounts of required background knowledge, and large amounts of text to cover in short time periods. Additionally, many of these texts are poorly organized. Given the well-documented deficits that students with learning and attention disabilities have in the area of working memory (e.g., Holmes, et al., 2012; Swanson & Sachse-Lee, 2007) these textual complexities are especially problematic. Additionally, cognitive load theory would suggest that factors such as text density, complexity, and length can place unmanageable loads on students' abilities to process and understand expository text information (Mayer, Heiser, & Lonn, 2001; Sweller, J. 2003). These demands put adolescents in an untenable situation that inevitably leads to disengagement and ultimate withdrawal from the learning task altogether (Shanahan & Shanahan, 2008). One tactic that has been used to make the demands of texts clearer and more understandable has been through the use graphic organizers (DiCecco & Gleason, 2002; Novak, 2002; Pashler et al., 2007). Graphic organizers are visual and spatial displays to facilitate the teaching and learning of textual material through the "use of lines, arrow, and a spatial arrangement that describe text content, structure, and key conceptual relationships" (Darch & Eaves, 1986, p. 310). While there is an extensive body of research that documents the effectiveness of using graphic organizers on reading comprehension, writing, and content-area subject learning (i.e., Kim, et al., Ellis & Howard, 2007), generic graphic organizers tend to loose their effectiveness when teaching the more advanced discipline-specific literacy standards and complex information associated with the secondary school curriculum. *Differentiated Visual Tools* are specifically designed to target this limitation.

What is the Differentiated Visual Tools Model?

The Differentiated Visual Tools Model is a K-12 discipline-specific approach to systematically teaching content information while integrating instruction in key information processing strategies addressed by Common Core and Career Readiness Standards. The model has three primary components: (a) use of specialized graphic organizers, called *Differentiated Visual Tools* (DVTs); (b) a three-stage paradigm for providing DVT-based instruction and formative assessment; and (c) tools and strategies for supporting and assessing fidelity implementation of the model. The DVT Model is based on thoroughly researched principles of instruction and design, and is scientific research-validated in classrooms. The DVT Model is based on the following principles and assumptions:

- Skill and knowledge development can be enhanced without compromising the integrity of the curriculum by reducing the cognitive load of both teachers and students.
- As curriculum becomes more complex, clarity of instruction becomes more critical.
- The Core Language Arts / College and Career Readiness Standards are developmentally sequenced, so instructional resources for teaching them should be scaffolded accordingly.
- Teachers' opportunity and energy for planning is extremely limited, so instructional resources should expedite the planning process as much as possible.
- Learning is maximized when students are engaged, and instruction is explicit, developmentally appropriate, and scaffolded.
- Use of visual and semantic prompts are among most powerful tools teachers can employ to facilitate learning. Visual prompts can enable teachers and students to see how to-be-learned information is

structured as well as see how to engage in complex information processing tasks. Semantic prompts can help teachers and students focus on critical information about a topic as well as cue learners to engage in specific information processing tasks.

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- There are generic information processing strategies that are required to understand and communicate about information in all disciplines, and there are specific information processing strategies and "ways of knowing" that are unique to specific disciplines. Both types of literacy strategies are important for students to master.

- While it is imperative that teachers effectively employ scientific research proven instructional tactics for maximizing student engagement and learning, teachers need latitude on the selection of tactics that best align with the instructional styles and values of teachers, the learning preferences of students, and the contexts in which instruction is to be delivered.

What are Differentiated Visual Tools?

DVTs are specialized graphic organizers that employ both visual features and embedded semantic prompts that are individually designed to teach *specific* content and literacy standards in a manner that reduces teacher's cognitive load and maximizes learning. DVTs are *differentiated* in three ways:

DVTs are discipline-specific.

Individual DVTs target high-frequency topics (HFTs) within a specific content-area. These are generative topics that are frequently addressed during content-area classes. For example, it is highly likely that any given middle school science lesson will primarily be about a *Phenomenon, Procedure, Process, Discovery, Life form, Structures and Systems*, etc. History HFTs include *Famous People or Groups*, *Issues/Conflicts*, *Eras/Movements*, *Policies/Laws, Processes*, etc.. Literature HFTs include Analysis of *Themes / Characters/ Plots, Literary Devices*, *Generative Ideas about Interpersonal Relationships*, *Social/Societal Issues, Differences in Beliefs / Cultures, Personal Journeys/Growth,* etc.

Each HFT within a discipline has a set of *generative essential understandings* (GEUs). These are important key ideas about a HFT that are *universal,* thus apply to all manifestations of the HFT.

If, for example, a science lesson is primarily about a ***process***, there are topics that are very important to understand about any process [e.g., *relevance of the process, critical features of each step in the process, conditions necessary for the process to take place, factors that affect the process, things the process affects*). Thus, regardless of which process the lesson is about, it is still important to address the same basic set of GEUs. DVTs about a process therefore contain embedded semantic prompts designed to cue teachers and students to focus attention on these important GEUs (See Figure 1).

Likewise, a different science lesson may be primarily about an important ***discovery***. Since what is essential to understand about important discovery is different from what is essential to understand about a process, DVTs that target discoveries have their own unique set of prompts focusing on discovery GEUs (e.g., previous discoveries leading to this one, what the discovery provided a greater understanding of, critical features of the discovery, applications/implications, positive/negative impact, etc.). These prompts serve to dramatically focus instruction on critical content knowledge (see Figure 2).

DVTs are literacy-specific

The Common Core / Career Readiness Standards focus primarily on a series increasingly complex information processing skills; some are generic in nature (e.g., *Differentiating between information explicitly provided by the text from inferences drawn by the reader*) (see Figure 3). Some are more unique to a specific discipline. For example, *Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced* is a CCSS literacy standard associated with "Reading Science" but is not a standard for "Reading Literature." (see Figure 4). Each DVT is individually designed to explicitly address (a) the to-be-learned content (generative essential understandings about the topic), and (b) generic and/or discipline-specific literacy skills.

DVTs are developmentally sequenced

Teachers are often faced with teaching the same content and literacy standards to students whose abilities and background knowledge differ greatly. DVTs are developmentally sequenced. (simple-to-complex) to facilitate scaffolded instruction commensurate with students' individual Zones of Proximal Development (ZPD) and thus provide teachers with practical ways to provide developmentally–appropriate, differentiated instruction. When teaching the same literacy standards to students whose abilities differ markedly, teachers can employ less complex DVTs for some students and more sophisticated ones for other students,. For example, since students' persuasive writing skills may differ markedly within the same classroom, some students will respond best to relatively simple versions of *Persuasive Writing DVTs* whereas the ZDP of advanced students can be more effectively addressed by teaching them how to use much more sophisticated versions of *Persuasive Writing DVTs*.

Figure 1. Science DVT addressing some of the essential understandings of a **process**

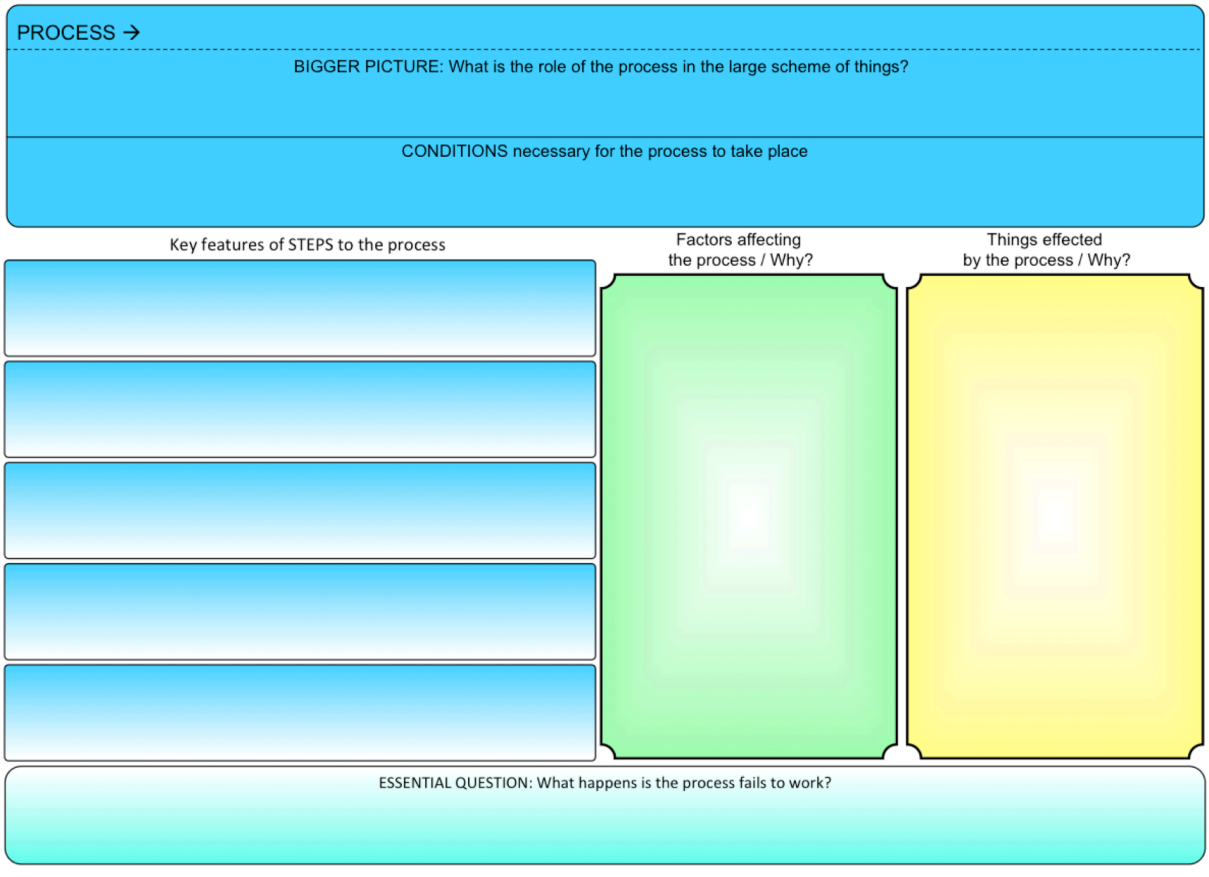


Figure 2. Science DVT addressing some of the essential understandings of a **discovery**

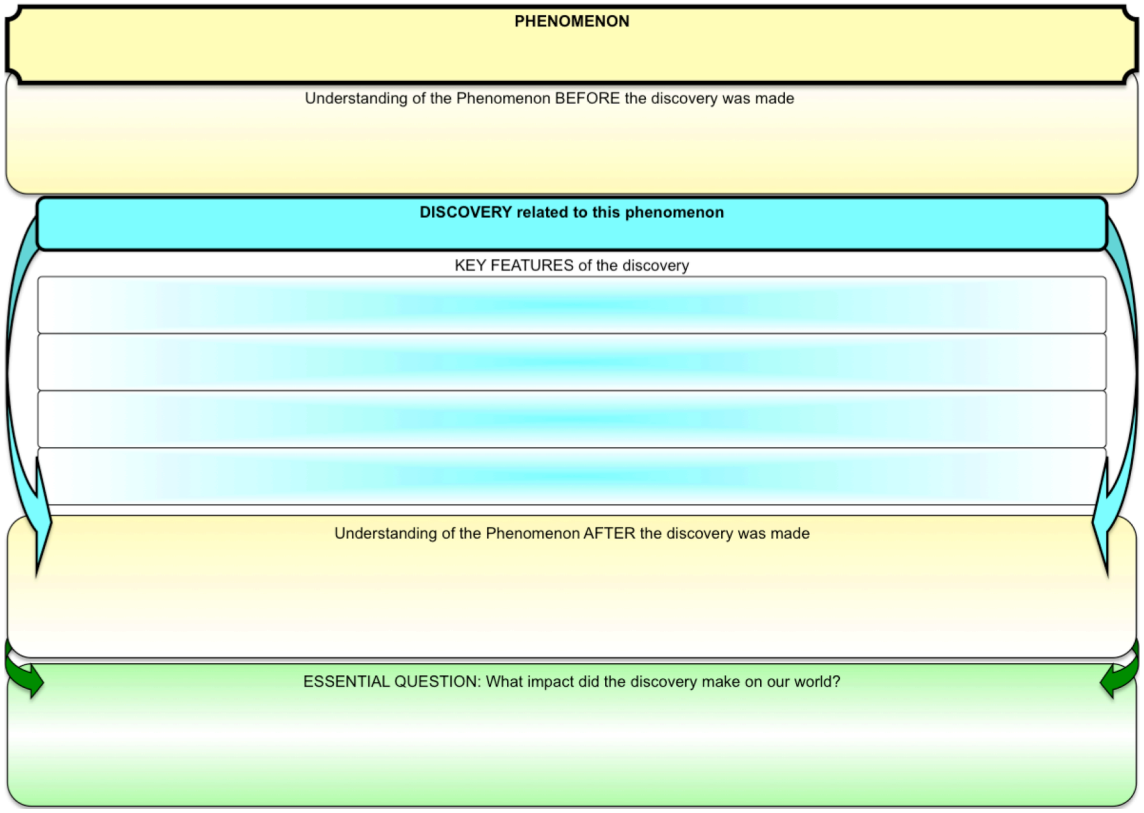


Figure 3. Science DVT addressing some of the essential understandings of a system and generic literacy standards (e.g., *differentiating between information explicitly provided by the text from inferences drawn by the reader*).

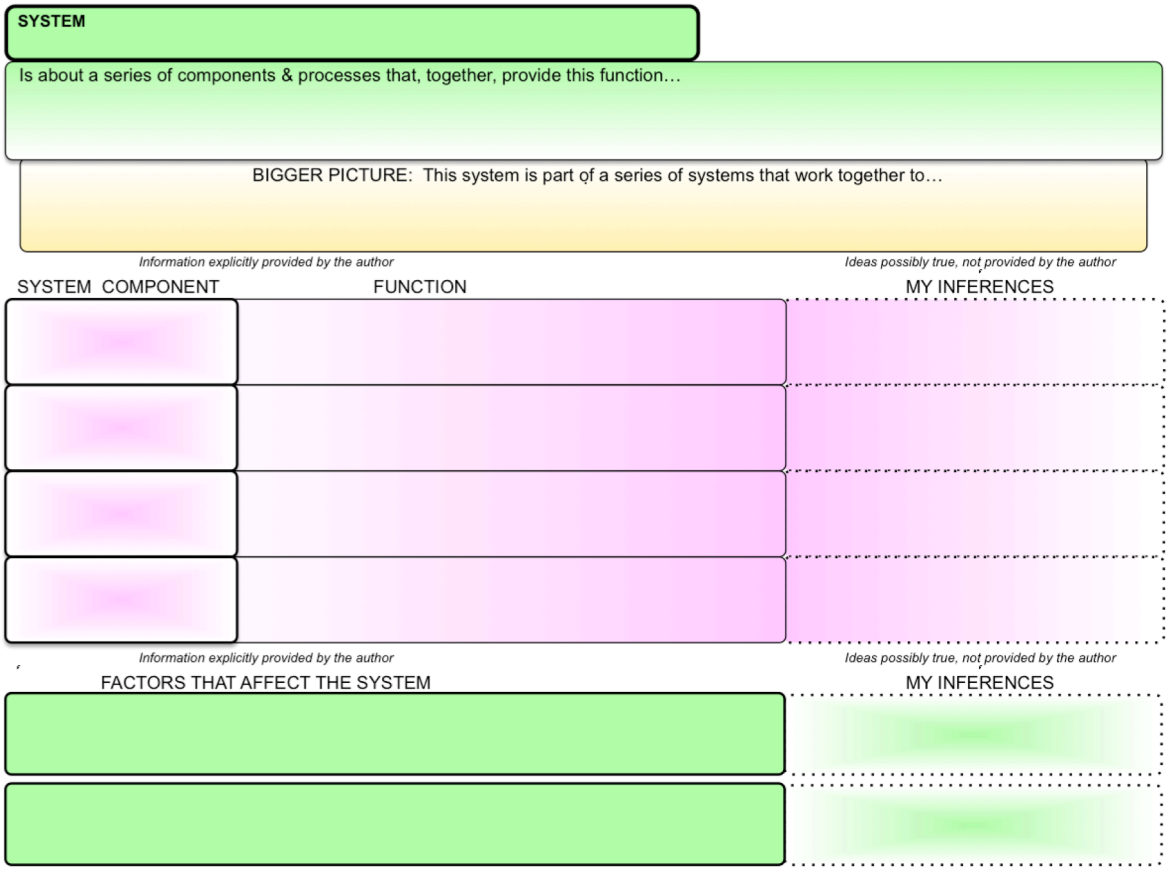
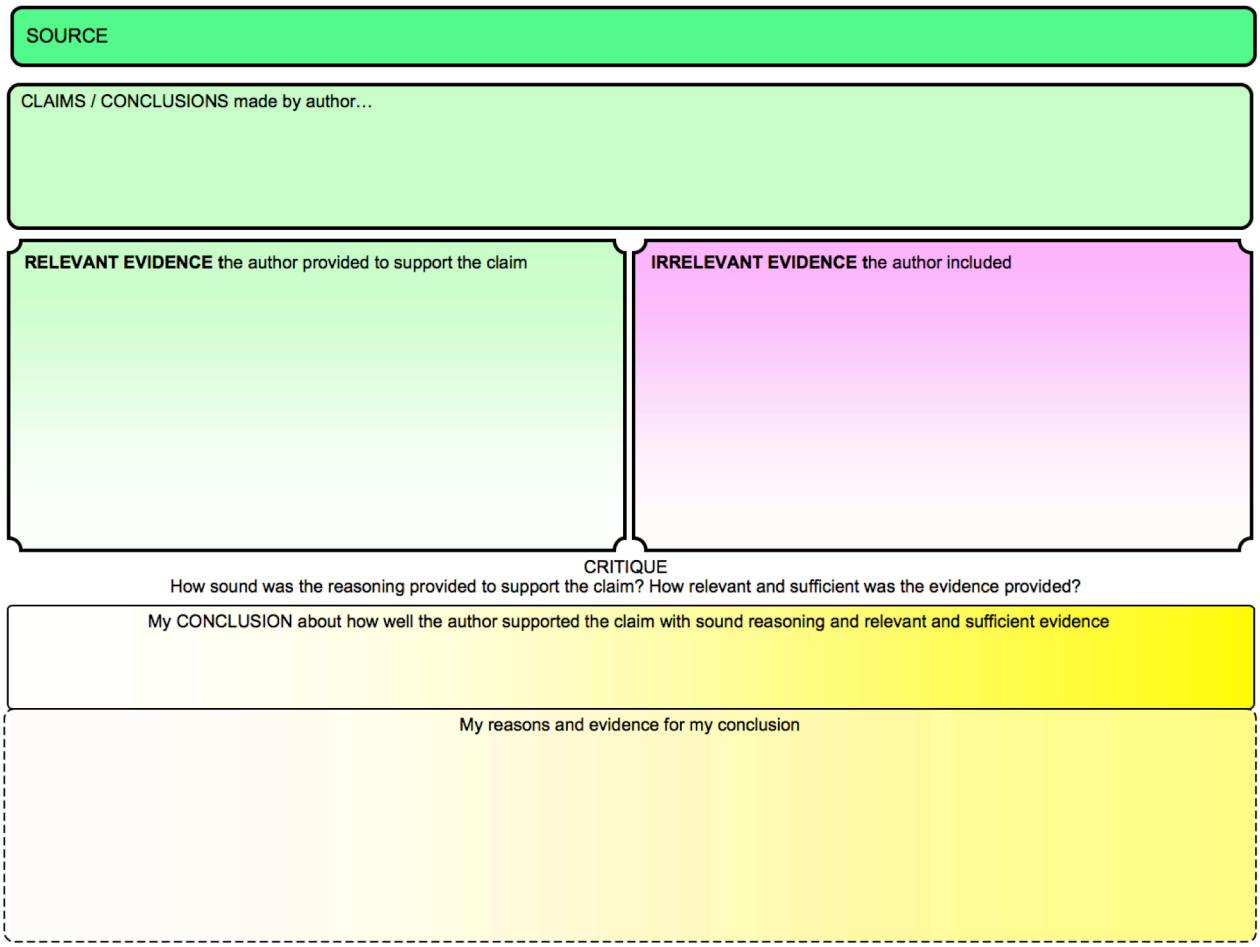


Figure 4. Science DVT designed to target discipline-specific literacy standards (e.g., *delineating and evaluating the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.*



How are Differentiated Visual Tools designed to reduce cognitive load?

DVTs are designed to reduce teacher's cognitive load when planning and delivering instruction and students' cognitive load when learning complex information and sophisticated literacy strategies.

While traditional generic graphic organizers depicting basic information structures like webs or Venn Diagrams usually work well when targeting relatively simple literacy standards (e.g., *CCSS.ELA.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts*), their utility is lessoned considerably when applied to more advanced literacy standards (e.g., *CCSS.ELA-LITERACY.RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem*) as well as when subject-matter is complex and dense (e.g., *NGSS HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process oxygen molecules of food molecules and oxygen molecules are broken and the bonds in new chemicals are formed resulting in net transfer of energy*). Determining how to embed instruction in advanced literacy standards into content-area lessons creates significant cognitive load on teachers. DVTs address this challenge by using design features that reveal how to address complex standards in relatively simple, straightforward ways, thus significantly reducing cognitive load (see Mayer & Moreno, 2003).

Likewise, while generic graphic organizers can be very helpful to learners because they reveal how the to-be-learned information is structured, effective use of them when teaching complex information requires planning that can be cognitively demanding and time consuming. For example, when planning to teach complex information, teachers must differentiate between ideas that are essential for students to learn from less essential peripheral information, determine how the information is best organized, and then develop a graphic organizer that effectively depicts these ideas. The cognitive load associated with making these instructional decisions is considerable, so consequently, many teachers simply do not bother, choosing instead to take a "explain and hope" strategy when teaching complex ideas (e.g., attempting to extemporaneously explain complex ideas to students, and hope they are sufficiently skilled and intelligent to discern how the ideas are best organized, which are essential to understand, etc.).

As previously noted, the embedded prompts on DVTs target generative essential understandings (GEUs). Because the GEUs appear on the DVTs in the form of semantic prompts, teachers planning lessons are not required to determine what they should be. In short, the GEU prompts are another way the DVTs reduce teachers' cognitive load. This design feature is greatly valued by teachers, as evidenced in comments from qualitative measures designed to assess high school history teacher's perceptions and value of DVTs (Wills 2007).

What is the DVT Instructional paradigm?

Effective DVT instruction follows a 3-stage instructional sequence.

Stage 1: Information-to-DVT Notes
During Stage 1, teachers provide scaffolded assistance (gradual release) as students learn to transform essential understandings of content information that is orally presented in class, media, or text to notes on the DVT. Stage 1 instruction typically occurs at the beginning (e.g., using DVTs as advance organizers as well as to activate / review background knowledge) and during the heart of the lesson (e.g., using DVTs when teaching new content). The role of the teacher is to introduce (or review) the DVT's purpose and features, and then provide content instruction while using the DVT as a note-taking guide as information to be noted on the DVT is co-determined by the teacher and students or by students working collaboratively without teacher assistance.

Once students are familiar with specific DVTs, they can also be used to facilitate student-research and other project-based learning experiences. Thus, DVTs are not only tools for providing teacher-directed explicit instruction in science content and literacy strategies, they also may serve as very effective student-directed tools (Ellis Project-based Learning CITE). .

Stage 2: Notes-to-Verbal Elaboration
During Stage 2, students practice verbally explaining the information that was noted on the DVTs to peers. This practice targets three important learning processes. First, a significant body of research demonstrates that when students make precise elaborations of the information they are learning to others, the depth, breadth, accuracy and recall of their own knowledge significantly increases (Pressley CITE).

Second, recall that in addition to facilitating content learning, DVTs are also designed to address specific information processing strategies such as drawing inferences; thus, as students are

explaining the ideas noted on the DVT to peers, they are also addressing the embedded information processes skills targeted by the DVT. For example, when students are explaining ideas noted on a *Drawing Inferences DVT* about an experiment,
they are explaining the essential ideas about the experiment that was explicitly provided by the text, and they are describing the inferences they drew about the experiment and why they think the inferences might be true (see Figure 3).

Third, when students practice verbally explaining the ideas noted on the DVT, they are building language fluency with these ideas as they are internalized. In essence, the more they verbally explain the complex ideas, the easier it becomes to explain them, both verbally and in writing. The net result is a significant reduction in students' cognitive load when writing narrative, expository or persuasive essays about the topic they have been studying or investigating.

Stage 3: Notes-to Writing
During Stage 3, students use their DVT notes as their guide when writing essays about the topic targeted by the DVT and/or when making oral presentations about a topic they have been investigating. Stage 3 typically occurs at the end of a lesson and as independent work assignments completed outside of class. This practice targets three important learning processes. First, it is based on the learning principle that students' relational understanding and memory of content information is considerably enhanced when they write about it.

Second, when students use the DVTs when writing, they are developing key narrative, expository, and persuasive writing skills targeted by the Core and Career Readiness Standards. The breadth and depth of their essays tend to be significantly enhanced, in part because the Generative Essential Understanding prompts on the DVTs causes them to focus on critical and substantial information concerning their topic.

Third, students' essays and presentations also serve as forms of formative assessment. Analysis of the ideas noted in their essays or presentations tends to quickly reveal the degree to which students understand the content addressed by the DVT, what they understand about the literacy skills targeted by the DVT, and how well they can articulate both of these kinds of understandings in writing or when presenting.

Instructional Stratagems within each Instructional Stage.
Teachers may choose from a collection of specific teacher-assisted, peer-assisted, or self-(student) directed instructional "DVT Stratagems" designed for each of the three instructional stages. Each Stratagems is based on principles of scaffolded instruction and tactics for maximizing student engagement.

Is the DVT Model research based?

Previous research
The idea behind DVTs derived from observing novice as well as seasoned teachers use generic ready-to-use "blank" graphic organizers (GOs) like webs, Venn diagrams, and boxes with arrows depicting causal relationships. In particular, I noticed two things. First, the information science teachers chose to put on the GOs too often failed to reflect critical information about the topic they were teaching, and very rarely addressed generative understanding nor implications/ relevance of the information. Second, I noticed how much planning time and effort was required by teachers in order to identify substantially important ideas to address when using the visuals to teach content-area subjects. This

seemed to be especially true with novice teachers, even when the subject matter was relatively simple (4th and 5th grade science). I observed that when the essential understanding prompts were provided in advance, teachers did not have to spend as much time and energy planning lessons, and the quality of their lesson plans as well as depth and breadth of their instruction seemed to significantly increase.

Second, I also noticed a relationship between grade levels and use of generic graphic organizers – the more advanced the grade levels, the less likely teachers seemed to incorporate graphic organizers (GOs) into their instruction. In part, I surmised, this was due to the amount of time and effort (cognitive load) that was required to develop the GOs. The work of Tim Shanahan (CITE) and other discipline-specific literacy researchers shed additional light on this problem by demonstrating that the complexity and multi-dimensional nature of concepts taught in upper grades simply did not readily lend themselves to simple generic GOs. Collectively, these and similar observations and experiences working with teachers and students led to a line of research and development that eventually resulted of formation of the DVT Model.

The development of the DVT Model has been based on "design studies" articulated by a number of researchers (e.g., Bannan-Ritland, 2003; Bannan-Ritland & Back, 2008; Kelly, 2004; Kelly, Lesh, & Baek, 2008; Shavelson, Phillips, Towne, & Feuer, 2003) in which "the design act is comprised of different studies belonging in stages within a larger trajectory that animates the program or portfolio of work" (Kelly, 2004, p. 125). Essentially, development of the DVT Model has been, and continues to be, an evolving process. Iterations of DVTs, the 3-stage instructional paradigm, and the nature of resources, professional development, and support within schools that teachers need to implement the DVT Model effectively are based on a combination of action research and beta testing, empirical data collection using scientific research designs, program evaluations, and most importantly, on-going feedback from teachers and students (see Shavelson et al., 2003). For example, an ongoing series of classroom-based action research studies examining how novice and seasoned teachers planned and delivered DVT-based instruction and how students responded to it, paired with feedback from participating teachers and students, resulted in incremental changes to what became the DVT Model. These studies influenced how DVTs are designed, the DVT instructional paradigm, and the nature of DVT instructional planning and delivery resources that teachers need. These studies eventually led to large N studies using scientific research designs to empirically validate the DVT Model.

Large N research studies indicate that DVT-based content instruction (e.g., American History) was significantly superior to traditional text-based / guided note-taking instruction on measures of gains in students' depth and breadth of new knowledge. These results were found in high-, typical- and low-achieving students, as well as low achieving students classified as learning disabled. These results were consistent across all teachers participating in the studies (for a review, see Ellis, Deshler & Wills, 2010). Feedback from teachers and students participating in the studies also led to substantial changes in the DVT Model.

Qualitative measures indicate that both teachers and students highly value DVTs and perceive them as both tools that improve instruction and learning while also reducing cognitive load (Wills, 2007).

Program evaluation studies investigating DVT-based instruction's impact on high stakes writing assessment performance in 26 schools indicate that, when compared to schools' test performance (e.g., % of students who met or exceeded performance standards) prior to DVT implementation,

performance markedly increased after a year of DVT-based instruction, regardless of the schools' prior performance history, including historically high-performing schools. The most significant gains were found in very low performing schools on "alert" status. The relative impact of DVT-based instruction gradually diminished in schools with increasingly higher levels of prior performance on the state writing assessment, but nonetheless, all schools demonstrated significant gains in test performance.

Studies examining the impact of DVT-based instruction in schools with matched prior test performance histories, but differing in economic status, demonstrated significant increases in test performance, regardless of the economic ecology of the schools. Similar results were found in rural vs. metropolitan schools. In short, there is a consistent improvement in writing high stakes assessment performance when DVT-based instruction was implemented.

In-process DVT research and development

As noted above, DVT research and development is on going, and the DVT Model continues to evolve. For example, teacher feedback has led to the current focus on developing and validating a series high school course-based DVTs for Algebra, Biology, English, and American History. Also in process is a series of studies investigating the effectiveness of infusing on-line high school courses with DVT-based instruction.

Invitation to collaborate on future DVT research and development

The DVT Model is a rich source for research opportunities for many different types studies (development and validation studies, program evaluation/fidelity studies, studies investigating ways to facilitate DVT professional development and implementation, impact on specific literacy skills, etc.). These studies may range from relative simple action research/Masters Thesis-type studies to more sophisticated and complex studies such as those associated with PhD. Dissertations or funded research. Interested researchers should contact Ed Ellis to discuss various ways to become involved in DVT research and development.

SIM *Learning Strategies Curriculum, Content Enhancement Routines, and Differentiated Visual Tools Connections*

As one of the original developers of SIM and author several of the strategies in the *Learning Strategies Curriculum* (LSC) as well as several *Content Enhancement Routines* (CER), I'm a firm believer in the robustness of both LSC and CER. The DVT Model is an approach to enhancing content instruction, and it's also an approach to teaching specific literacy strategies. As such, the DVT Model is best viewed as part of the family of SIM Interventions and as highly complimentary to LSC and CER and thus can be used in conjunction either set of interventions.

DVT Model* comparison with the *Learning Strategies Curriculum.

DVTs differ from LSC in that the latter are designed primarily for students who struggle with learning and have failed to develop effective learning strategies on their own. LSC features intensive instruction using precise progress monitoring in settings conducive to clinical instruction. The learning strategies featured in LSC are designed to be universal, and thus can be used across all disciplines. Specific LSC strategies also can be used to target instruction at specific generic literacy strategies addressed by Common Core Standards, such as those associated with identifying the

central message and supporting details from text or drawing inferences. The LSC strategies are not designed to target discipline-specific literacies.

The most prominent features of LSC are the sets of systematic steps to each learning strategy encapsulated with first-letter mnemonic devices, the instructional Stages of Acquisition and Generalization, precisely scaffolded practice activities, and the use of precise progress monitoring / formative assessment. LSC strategies that are selected for instruction are based on the setting demands of students and their individual needs. Thus, LSC instruction typically is implemented as a Tier 3 -Response to Intervention (RTI) form of instruction.

In contrast, the DVT Model targets both generic and discipline-specific literacy strategies targeted by specific Common Core /Career Readiness (CC/CR) Standards associated with reading, writing, and vocabulary forms of literacy. Individual DVTs are designed to teach specific CC/CR Standards .

As previously noted, DVTs are developmentally sequenced in the tradition of scaffolding complexity. For example, some forms of comparison are more complex than others. Thus DVTs include relatively simple comparison visuals as well as much more sophisticated versions for more sophisticated learners who share the same classroom. While formative assessment strategies are used in the DVT Model, they are not designed for the kinds of precise progress monitoring that is associated with LSC.

While the DVT model is primarily a Tier 1 RTI approach to instruction, the developmental nature of DVTs make them conducive to differentiating instruction based on individual students' needs, so it can also be considered a form of Tier 2 RTI intervention.

LSC strategies employ first-letter mnemonic devices to encapsulate the specific strategy steps. These memory devices serve as a form of prompts that cue students to engage in specific actions associated with the strategy. In contrast, DVTs employ visual design features and embedded semantic prompts as mechanisms designed to cue students to engage in various learning actions.

DVT Model* comparison with *Content Enhancement Routines

CER and DVT-based instruction are both forms of Tier 1 instruction within the RTI paradigm. Both CER and DVT visuals employ visual features to help teachers and students see how the targeted information is structured, and both employ embedded semantic prompts designed to cue students to engage in specific information processing tactics. While CER visuals are universal in the sense that the same tool can be used when teaching literature, History, history, or math, DVTs are not. Rather, DVTs are discipline-specific and thus also feature semantic prompts that focus on essential understandings of high-frequency topics within different disciplines while CER visuals do not. Teachers and students report that these prompts significantly reduce cognitive load (Ellis, Deshler & Wills, 2010; Wills, 2007).

Likewise, the CER visuals are universal in the sense of "one-size fits all" (e.g., the visual tool associated with the *Concept Comparison Routine* can be used effectively with 7th and 12th graders alike) while DVTs are not designed this way. Rather, to facilitate differentiated instruction based on the development needs of learners, DVTs within a strand often feature a simple as well as more complex versions.

Although the instructional tactics in both CER and the DVT Model feature research-proven explicit instructional tactics for maximizing student engagement and learning, the instructional paradigms

differ. Each CER features a unique visual tool and that is accompanied by a set highly robust step-by-step instructional procedures that have been encapsulated by a first-letter mnemonic device to help teachers remember the instructional steps and their order. In contrast, the DVT Model utilizes a 3-stage instructional paradigm. For each stage of instruction, a menu of teacher-assisted and peer-assisted instructional options are provided so that teachers can select those options that best fit their own teaching styles, learning preferences of students, the level of scaffolded assisted needed, and the context in which the instruction is being provided.

How can teachers access the *Differentiated Visual Tools* programs?

Currently available are K-12 software applications of the DVT Model organized by grade-levels and discipline. The DVT programs for the primary and intermediate grades focus on reading and writing about information and literature CC/CR Standards as well as teaching vocabulary and content-area subjects like social studies and science. The *K-5 Vocabulary DVTs* program features of a series of scaffolded DVTs ,designed for teaching vocabulary, and the same time, integrate key information processes strategies that parallel those featured in CC/CR (e.g., identifying central message and critical details, forming predictions and inferences, asking and answering questions, etc.). They also address word types and extremes and idioms.

The currently available DVT programs for secondary grades focus on middle school discipline-specific CC/CR Standards for reading and writing about science, history/social studies or literature; The DVTs in each program target generative essential understanding of high-frequency topics within each discipline. The *6-12 Vocabulary DVTs* program features of a series of scaffolded DVTs designed for teaching vocabulary terms with precise definitions as well as DVTs for terms with elaborated definitions. As previously noted, high school course-specific (Biology, American History, English 9, 10, 11, and 12) DVT programs designed as supplementary instructional resources are currently under development. Subscribers to the SIM Network List-serve will be notified as they become available.

For immediate download, single-user licenses for these programs can be purchased online at www.DifferentiatedVisualTools.com. CDs and multi-user licenses of these programs are available from Edge Enterprises, Inc.(www.EdgeEnterprisesInc.com)

Are DVTs appropriate for use in states that have not adopted the Common Core State Standards?

A number of states have not officially adopted the Common Core State Standards (CCSS), but their literacy standards nonetheless very closely parallel them. Also, while the prose of literacy curriculum standards in some states does not appear to parallel that of CCSS, the actual competencies associated with using information processing strategies for reading and writing and thinking skills tend to be very similar, especially in grades K-5. Thus the DVT Model can be a valuable instructional resource for those states.

Where some of these state standards differ (at this point in time), tends to be the absence of discipline-specific standards at the secondary level and/or absence of some of the more advanced skills targeted by the 6-12 CCSS literacy standards. Important to remember is that while the DVTs are designed to address critical literacy and thinking skills, they are *also designed to address generative*

essential understandings of content-area subjects. Thus, regardless of the literacy standards adopted by a state, the DVTs can be valuable tools for addressing the content standards found in all states.

Differentiated Visual Tools Professional Development

The DVT Model approach to professional development (PD) utilizes a multi-dimensional approach, featuring face-to-face PD provided by qualified individuals, as well as technology-assisted PD. Certified SIM Professional Developers (PDrs) interested in sharing information about the DVT Model are provided as range of resources downloadable from SIMville (http://www.kucrl.org/simville). These include overview presentations about the overall DVT Model, as well as specific overview presentations about specific programs, and free "demo" versions of each of the programs. I have found that audiences who are already familiar with the *Content Enhancement Routines* very quickly see how the DVTs can dovetail with them.

Technology is being harnessed in a variety of ways to enhance professional development. For example, each individual DVT in the in the *6-8 Science DVTs* program has a link to a brief video that explains the purpose and design of the DVT and CC/CR standards it is designed to target. During the explanation, an example of how a teacher used it unfolds, followed by a brief set of instructional tips and recommended Instructional Stratagems for using it. Like LSC and CER, various DVT PD resources (e.g., videos, workshop activities, presentations, etc.) provided by members of the SIM Professional Developers Network will be posted at SIMville as they become available.

REFERENCES

Bannan-Ritland, B. (2003). The role of design in research: The integrative learning design framework. *Educational Researcher, 32*(1), 21-24. doi:10.3102/0013189X032001021

Bannan-Ritland, B., & Baek, J.Y. (2008). Investigating the act of design in design research: The road taken. In A.E. Kelly, R.A. Lesh, & J.Y. Baek (Eds.), *Handbook of design research methods in education: Innovations in science, technology, engineering, and mathematics learning and teaching* (pp. 299-319). New York, NY: Routledge.

Conley, G. K. (2008). The effect of graphic organizers on the academic achievement of high school students in US History who receive instruction in a blended, computer-based learning environment. Doctoral dissertation, Liberty University.

Darch, C., & Eaves, R.C. (1986). Visual displays to increase comprehension of high school learning-disabled students. *Journal of Special Education, 20*(3), 309-318.

DiCecco, V. M., & Gleason, M. M. (2002). Using graphic organizers to attain relational knowledge from expository text. *Journal of Learning Disabilities, 35*(4), 306-320. doi: 10.1177/00222194020350040201

Dole, J. A., Duffy, G. G., Roehler, L. R., & Pearson, P. D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research, 61*(2), 239-264. doi: 10.2307/1170536

Ellis, E.S., Wills, S.A., & Deshler, D.D. (2011). Toward Validation of the Genius Domain-specific Literacy Model. Journal of Education 191(1), 13-32

Ellis, E.S., & Howard, P. (2007). Graphic organizers: Go for it. The Research into Practice Alert Series. Reston. VA: CEC Division of Research.

Gathercle, S.E., Alloway, T. P., Kirkwookd, H. J., Elliott, J. G., & Holton, K.A. (2008). Attentional and executive function behaviors of children with poor working memory. *Learning and Individual Differences,* 18, 214-223.

Greer, D., Deshler, D.D., & Rice, M. (2014). Principles of text complexity to online environments. *Perspectives on Language and Learning,* 9-15.

Holmes, J., Gathercole, S. E. Place, M., & Alloway, T.P. (2012). Working memory and ADHD. Manuscript in preparation.
Journal of Educational Psychology, 93, 187–198.

Kelly, A.E. (2004). Design research in education: Yes, but is it methodological? *Journal of the Learning Sciences, 13*(1), 115-128.

Kelly, A.E., Lesh, R.E., & Baek, J.Y. (Eds.). (2008). *Handbook of design research methods in education: Innovations in science, technology, engineering, and mathematics learning and teaching*. New York, NY: Routledge.

Kim, A.H., Vaughn, S., Wanzek, J., & Wei, S. (2004). Graphic organizers and their effects on the reading comprehension of students with LD. *Journal of Learning Disabilities, 37*(2), 105-118. doi: 10.1177/00222194040370020201
learning: When presenting more material results in less understanding.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multi-media learning. *Educational Psychologist,* 38 (1), 43-52.

Mayer, R. E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia

Novak, J.D. (2002). Meaningful learning: The essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. *Science Educator, 86*(4), 548-571. doi: 10.1002/sce.10032

Pashler, H., Bain, P.M., Bottge, B.A., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J. (2007). *Organizing Instruction and Study to Improve Student Learning* (NCER 2007-2004). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education.

Pressley, M., Wood, E., Woloshyn, V.E., Martin, V., King, A., & Menke, D. (1992). Encouraging mindful use of prior knowledge: Attempting to construct explanatory answers facilitates learning. *Educational Psychologist, 27*(1), 91-109. doi: 10.1207/s15326985ep2701_7

Shanahan, T. & Shanahan, C. (2008). Teaching discipline literacy to adolescents: Rethinking content-area literacy. *Harvard Educational Review,* 78 (1), 40-59.

Shavelson, R.J., Phillips, D.C., Towne, L., & Feuer, M.J. (2003). On the science of education design studies. *Educational Researcher, 32*(1), 25-28.

Swanson, H. L. & Sachse-Lee, C. (2007). Mathematical problem solving and working memory in children with learning disabilities: Both executive and phonological processes are important. *Journal of Experimental Child Psychology,* 79, 294-321.

Sweller, J. (2003). Evolution of human cognitive architecture. In B. Ross (Ed.), *The psychology of learning and motivation* (Vol. 43, pp 215-236). San Diego: Academic Press.

Wills, S. W. (2007). *The effect of embedded semantic prompts in graphic organizer Instruction on students' relational understanding of secondary content material*. Unpublished doctoral dissertation, The University of Alabama.