

Creating Lessons that Work: the TI-Nspire Challenge!

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Core Questions:

1. What structure(s) should we seek to impose on authors of TI-Nspire lesson documents (if any)? How prescriptive should we be?
2. To what extent could/should TNS documents be designed to be “free-standing” i.e. capable of providing the full detail required for a lesson sequence?
3. What do we mean by a “lesson sequence”? Do we want a step-by-step “how-to” guide, or a sequence of key *questions* perhaps, leaving teachers room to develop the lesson around these?
4. What are we trying to teach? Is it a single key concept or skill (such as “expanding a binomial expression” or “solving two-step linear equations”) or is it a mix of concepts and skills arising from a “rich task” or “application question”?
5. Other core questions...?

Accompanying this document are three files which develop the ideas presented here in the context of a particular exemplar lesson. These files consist of a TI-Nspire TNS document (*areas&paperfoldingA4.tns*), a PDF print-out of this file, and a PDF teacher support file. These are not offered as necessarily perfect examples of the principles described here, but rather as the basis of some further discussion.

Some Early Responses [\[includes Rob Foshay's comments\]](#)

1. *What structure should we seek to impose on authors of TI-Nspire lesson documents (if any)? How prescriptive should we be?*

While recognizing the undoubted skills, expertise and experience of our TI-Nspire authors, there is a need for at least an overlying consistency in the structure of documentation that is prepared, at least within a single framework (such as developing materials for our Pilot Schools) and we need to be responsive to the needs and wishes of these partners.

It would, at the same time, be highly desirable to be at least working towards what might serve as a classroom tested research-based framework which can be used and recommended in future development of all support materials.

At this point, two research models appear to me to be appealing:

Merrill (2006) identifies common principles in the various theories and models for instructional design, which he distills into a four-phase cycle of instruction:

1. **Activation**, in which students are directed to draw on previous learnings and knowledge relevant to the task at hand, which forms a foundation for new knowledge;
2. **Demonstration**, which involves active *portrayal* (rather than just telling) of the new knowledge, using specific and concrete examples applied to a particular situation;
3. **Application** involves more than just recounting; learners apply their new knowledge to complete whole tasks or solve entire problems; and
4. **Integration**, involving public demonstration of their learning and opportunities for learners to explore and use their new knowledge in new ways.

The backdrop for this cycle is a scaffolded problem solving environment, in which students are guided through appropriate tasks with direct instruction of components of the problem.

There are some concerns for me with this model. It fails to clearly highlight the importance of student use of language, putting their learnings into their own words as an essential part of the learning process. More significantly, it is a model which caters well for **direct instruction** but less well for **investigation** and **open-ended problem solving** – the “rich task” type learning environment which is becoming increasingly important in building learning experiences which are likely to be significant and worthwhile for the learners, and result in learning which is flexible and transferable. *It is also that type of learning best suited to the nature and purpose of TI-Nspire as a learning tool.*

An alternative may be available in long-term well-established work by Pierre (and, prior to her death, Dina) van Hiele.

The theory of van Hiele, in addition to describing levels of thinking, offers an important addition. This is the notion of *stages of learning* as means by which the learner may be assisted to seek higher cognitive ground. Five such stages are specified (van Hiele, 1986):

1. In the first stage, that of *information*, pupils get acquainted with the working domain.
2. In the second stage, that of *guided orientation*, they are guided by tasks (given by the teacher, or made by themselves) with different relations of the network to be formed.
3. In the third stage, that of *explicitation*, they become conscious of the relations, they try to express them in words, they learn the technical language of the subject matter.
4. In the fourth stage, that of *free orientation*, they learn by general tasks to find their own way in the network of relations.

5. In the fifth stage, that of *integration*, they build an overview of all they have learned of the subject, of the newly formed network of relations now at their disposal. (pp. 53-54)

These stages of learning are significant in providing a framework for instruction aimed to develop understanding of the material or skills to be learnt. The significant role of language (and, by implication, social interaction) is clearly indicated, and behind this model lies a recognition of the need for students to experience what van Hiele refers to as a “crisis of thinking” if learning is to be truly effective, and the learner is to be moved forward, cognitively.

My suggestion, at least initially, is a blending of these two instructional models into a five-phase model of instruction which may serve to guide the development of learning experiences that we are to develop using TI-Nspire. These are elements of instructional design - I am NOT necessarily implying a rigid sequence for these! (All should at least be PRESENT).

1. Activation/Information (Introduction?)

Students are introduced to the task in the context of previous learnings, clearly situating the task in relation to existing knowledge and skills. This phase, ideally, should also clearly specify the nature and/or goal of the learning so that students have some idea of where they are going and why. I would not be uncomfortable with specifying learning outcomes up front (“At the end of this lesson, you will be able to...”) as long as these do not restrict the instruction to the lowest and easiest to specify cognitive aspects.

2. Demonstration/Guided Orientation (Orientation?)

If the purpose of the lesson is to achieve a single skill or concept, then demonstration through worked example is quite appropriate. If the task involves multiple skills and concepts in pursuit of a rich learning goal, then guided orientation is far more suitable. In both cases, students begin working within the domain of the task, in a scaffolded and purposeful way, following fairly direct instructions.

3. Explicitation (Verbalisation?)

Throughout the learning process, students should regularly be required to verbalise their understandings, to put what they are learning into their own words. This is critical within a social learning situation (classroom) and offers invaluable evaluative information for the teacher. TI-Nspire offers an additional tool in this regard, supporting students in entering their own responses within the document, forcing them to verbalise (ideally in both spoken and in written forms). This will be unfamiliar ground initially, for both teachers and students, and materials we develop should serve to lead them towards such use, promoting it as highly desirable. As the use of TI-Navigator becomes more widespread, these are exactly the issues we will be facing and, once again, it will be desirable to encourage and promote such verbalization as a regular and essential part of the learning sequence.

4. Application/Free Orientation (Consolidation?)

Again, Merrill's approach works well for a traditional instructional sequence: introduction, worked examples, practice and consolidation. In a technologically rich learning environment, students will be provided with tools with which they will consolidate and put into practice what they have been introduced to. Ideally, of course, both elements will be part of the learning sequence: the facility to explore what they are learning in a powerful and active way, and then opportunities to practice and reinforce these concepts and skills.

5. Integration

*Both models agree that, once the essential skills and knowledge have been established, students need to be provided with opportunities to extend and apply their learnings in novel and varied situations. Again, this may be scaffolded using technological tools and/or group work in a classroom setting. It should also culminate in some sort of tangible **product** or **performance** which brings it all together.*

[RF: I think it is incumbent on us (TI) to provide leadership on "best practice" uses of TI-Nspire. That's especially true for document structures: unless you understand document structure fully, I think the default is to approach TI-Nspire as an "84 on steroids" and focus on multiple representations, ease of notation, etc. In a conversation this morning about this issue, Gail Burrill had an interesting suggestion: let's think of a document as defining a learning environment. Without putting words in her mouth, when I think of a learning environment, I think of a bunch of tools/affordances, resources, learning activities, assessment strategies, etc. which are all intended to facilitate a particular intended learning outcome. The learning environment thus scaffolds both the student and the teacher.

I think the structure of these "learning environments" should reflect the teaching structure guidelines the math advisors are developing for the TTT/TTL project. Ideally, lessons produced to exemplify those guidelines should be prototype exemplars of applications of instructional models which are designed for particular types of intended learning outcomes. The work SRI now has under way on instructional models should help us define a plausible "universe" of these models. As we develop an understanding of these models, we can express them as templates for creating documents, and perhaps provide supporting documentation on how to use each template. Over time, we thus could evolve a library of learning environments/documents/instructional models/templates, all of which are consistent with the teaching guidelines, and which are designed to teach commonly-occurring knowledge types and to solve commonly-occurring teaching (instructional design) problems.]

2. To what extent could/should TNS documents be designed to be “free-standing” i.e. capable of providing the full detail required for a lesson sequence?

TI-Nspire offers, for the first time, the opportunity to *genuinely embed* instruction and assessment within the technology that supports the learning. This opportunity is far too valuable to overlook, and we should seek, wherever possible and appropriate, to deliver our instructional content using the TI-Nspire document system.

Limitations do exist, of course, and it is not envisaged that the documents become too large and unwieldy. Hence, we might consider the following as *desirable* inclusions within our TI-Nspire document files:

1. A title page which phrases the question or task, or introduces the activity in some clear way.
2. Some specification of the desired learning outcomes, in a format meaningful for both student and teacher.
3. Use of the “Problem” structure to break the lesson into discrete parts (“bite-sized pieces”).
4. Frequent use of the Q&A structure within Notes, to ensure an interactive student-focused experience, rather than a series of instructions or pages of information. *This does suggest a lesson format built around student questions rather than teacher instructions.*
5. Limit Notes pages to a single screen wherever possible.
6. Offer and deliberately encourage the use of multiple linked representations within which the student plays an **active** role – **NOT a spectator!!**

It is likely that, in most cases, TI-Nspire document files will be accompanied by a more complete document, within which there is scope for developers to give more detailed background information and instructional suggestions. Such documents will also often supply sample solutions for teachers (and students, where appropriate!)

[RF: There will be times, of course, when more narrative or information is needed simultaneously than can be accommodated within the TI-Nspire screen, and for those times we will need to provide some kind of paper-based backup (printable PDF's, etc.). But I take your question more broadly to mean, "should documents be complete instructional sequences?" I think the answer is "it depends." Not very satisfying, but I think three principles should govern how complete we should try to be:

- Some learning environment components can only be provided (or best be provided) by human teachers. Examples are motivation, local contextualization, some kinds of feedback, inference about causes of errors, and instructional management. For these components, we would do well to provide as much teacher scaffolding as we can, and to include training on them in our professional development. In an ideal world, I'd embed this scaffolding in something like side windows or "Clipit"-style suggestions which pop up only on the teacher's laptop when a lesson is running. But short of that, they can be in a print instructor guide.
- If our intent in content creation is to solve a fairly fully-defined teaching/learning problem, then I think we should provide free-standing documents (learning environments) along the lines discussed above.
- If our intent in content creation is only to provide a tool or single component of a learning environment which exists outside of TI-Nspire, then we should provide only that tool/component, and provide enough scaffolding around its use so that teachers can quickly and easily integrate it into their curriculum (in a matter of moments when they are planning the week's lessons on Sunday night). This situation describes most of what's available for download for existing GC's.

3. *What do we mean by a “lesson sequence”? Do we want a step-by-step “how-to” guide, or a sequence of key questions perhaps, leaving teachers room to develop the lesson around these?*

As suggested above, an active TNS document should be largely made up of student questions, rather than detailed teacher instructions (First rule of effective lesson planning: What are THEY going to do? NOT What am I going to do?!)

Accompanying documentation (in MS Word or, more likely, in PDF format) may well consist of the Step-by-Step suggested lesson sequence, if this is considered necessary or appropriate. It is likely that for publishers' purposes, there will need to be a fairly detailed instructional sequence specified, but this will not always be the case.

[RF: Again, I agree with Gail that the preferred metaphor here is "learning environment" rather than "lesson sequence." Within a learning environment, I think it's reasonable to define prototype/example lesson sequences which are only meant to represent what *can* be done within the environment -- sort of a "quick start" guide or "cheat sheet." With experience, teachers can be expected to depart from these lesson sequences to use the learning environment in ways which meet the needs of their students.]

4. *What are we trying to teach? Is it a single key concept or skill (such as “expanding a binomial expression” or “solving two-step linear equations”) or is it a mix of concepts and skills arising from a “rich task” or “application question”?*

TI-Nspire represents a string shift away from single-focus instructional models. By its nature, it is a dynamically linked cross-representational tool, and it will be most effective within a learning environment which crosses learning boundaries and builds bridges of understanding, rather than silos of rigid thinking. In general, the use of TI-Nspire will best be demonstrated where the organizing principle of instruction is NOT the mathematical concept or skill but a rich question.

There is no doubt that the tool may be well used in what we might term a “textbook” or “examination” scenario, in which the goal is to learn how to efficiently produce a specified result. In such contexts, however, its use will differ little from previous technological learning tools.

It seems likely that the tool will “sing” in contexts which draw together a range of mathematical domains and processes and encourage more open-ended exploration of significant and applicable scenarios.

This is another one of those "it depends" questions. Sometimes there is a need for teaching a particular concept, principle or skill. More often, however, I suspect that thoughtful application of the teaching guidelines and instructional models will lead us to creating learning environments which support "rich tasks" which teach knowledge networks, rather than isolated knowledge pieces.

5. *Other core questions...?*

[RF: Inside every instructional strategy is an assessment strategy struggling to get out...As we develop these models/documents/environments/templates, we should use them for instruction and also for assessment. It would be a real shame if all we do for assessment on TI-Nspire is to package up a set of multiple choice questions.

We have said (in SRI's paper, and in subsequent messaging about TI-Nspire) that the device is designed to support improved formative assessment and differentiated instruction. There are a great many theoretical and strategic issues embedded in this part of the value proposition for TI-Nspire, especially when we get to P3 + Navigator. PLS and I have asked SRI to work on this issue next year.

We can think of a continuum of "completeness" of what we provide for a learning environment: at one end is a relatively usage-neutral tool or resource, for which the teacher has to supply all the missing pieces needed to create a complete learning environment. At the other end is a learning environment which is as complete as possible and fully scripted (something like "Success for All" in the US comes to mind). The traditional GC represents something near the first extreme, and TI-Nspire could certainly be used that way -- by a skilled teacher with the time to create all the missing pieces of the learning environment. But I suspect that most of the content created for TI-Nspire will represent something closer to the middle of the continuum -- and that will be a significant part of the value proposition for TI-Nspire compared to a conventional GC. A side implication of this is that content should be thought of as scaffolding the teacher as much as it scaffolds the student. This, in turn, should have an important effect on the nature of professional development. It could mean that TI-Nspire content created in this way will require less PD to get to more consistent implementation -- or at least, a different approach to PD. Perhaps we should start thinking in terms of levels of proficiency in using TI-Nspire, and structure the PD accordingly. What do we think the "learning curve" looks like? What's the difference between a "brown belt" and a "black belt" TI-Nspire teacher?]