

*Developing, Implementing and Evaluating HPL-Inspired Innovation:
VaNTH's Team Review Process*

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About VaNTH

The VaNTH ERC is an eight-year project predicated on the notion that bioengineering education can be enhanced by curricular changes that are rooted in learning sciences, learning technology and assessment principles and practices. Based on a National Academy of Sciences report entitled *How People Learn: Brain, Mind, Experience and School (or HPL)*; Bransford et al. 1999), VaNTH research teams are developing, implementing and evaluating the effectiveness of curricular innovations (e.g., modules, optimal classroom environments) in undergraduate bioengineering programs at each participating institution.

About HPL

HPL-inspired innovations fuse learning principles with learning technology (e.g., computer-based visualization programs, interactive simulations, Web-based "challenges", and Web-based delivery systems). Based on learning science research optimal learning is likely when we create learning environments that are:

- (1) *Learner-centered* in the sense that they take into account the knowledge, skills, preconceptions, misconceptions and learning styles of learners;
- (2) *Knowledge-centered* in the sense that they help students learn with understanding by organizing their knowledge around "key concepts" or "big ideas" of the subject domain area, and understanding the conditions under which different aspects of their knowledge are applicable;
- (3) *Assessment-centered* in the sense that they provide numerous opportunities for students to make their current thinking visible throughout a course so that their understanding can be refined as needed; and
- (4) *Community-centered* in the sense that they foster norms that encourage students to learn from one another, plus encourage faculty to do likewise.

These four principles are, themselves, "big ideas" that need to be translated into practical terms that fit the full context of the proposed innovation.

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A Team Approach to HPL-Inspired Innovation

Transforming education to conform to the learning principles in the HPL framework *and* incorporating computer technology into the educational process requires the knowledge and skills of an interdisciplinary team. Within VaNTH, this transformation begins early in the development process. Prior to implementation of an innovative curricular change, the proposed innovation is subjected to a “Team Review”. During this review, experts in learning sciences (LS), learning technology (LT) and assessment and evaluation (A&E) meet with experts in bioengineering to examine, in detail, the elements of a proposed innovation (e.g., a module). As depicted in Figure 1, each area of expertise focuses on a set of distinct, but complementary, design issues. The purpose of this brief note is to highlight the content and processes associated with these reviews.

(A) The Role of the Domain Expert

Team Review begins with a *relatively concrete* proposal developed by a domain expert. The proposal could be for a module on a limited topic (e.g., biotransport), a sequence of modules (a mosaic) or the revamping of an entire course. The elements of a proposal include:

1. *Problem specification.* The initiator has identified a set of substantive topics that have been difficult for students to master in the past (e.g., Free Body Diagrams in Biomechanics);
2. *Empirical evidence.* The nature and extent of the problem is easier to understand and specify when the domain expert has provided empirical evidence (e.g., the distribution of scores from prior exams).
3. *Learning Goals.* With a well-specified problem, measurable learning goals can be articulated.
4. *Measurable outcomes.* Well-articulated learning goals need to be translated into measurable knowledge-based outcomes and core competencies.

Having a well-stated problem, clearly defined learning goals, measures of outcomes and an operational description of the proposed module (designed to reach the stated goals) the expertise of the LS, LT and A&E collaborators can be brought to bear. The review process generally proceeds in an iterative fashion, with each area having its own set of issues and concerns.

(B) Key Issues for the Learning Scientist

For the learning scientist, the central issues in the Team Review include:

1. *HPL Principles*. Reviewing the extent to which the innovation contains appropriate content and activities associated with the four types of “centeredness” described in the HPL framework. For example:
 - Are learner’s preconceptions and misconceptions assessed?
 - Do learners receive feedback on their progress?
 - Does topical coverage include key principles?
 - Do learners have an opportunity to share their ideas with others?
2. *Knowledge-based assessment*. Determining if the proposed knowledge-based assessments are well aligned with the goals of the module; and
3. *Scoring*. Articulating how exams are to be scored in order to capture important learning outcomes (e.g., understanding, expertise, adaptive expertise).

(C) Key Issues for Learning Technology

Learning technology serves several important functions that can be infused into the module or innovation. These include:

1. *Delivery*. The use of technology to present the content in the module and through asynchronous presentation of additional out-of-class materials that support the learning objectives of the innovation;
2. *Formative assessment*. A main theme within HPL involves making materials learner- and assessment-centered. Technology provides a powerful vehicle for gathering these data.
3. *Tailored Delivery*. Learning with understanding can be facilitated by monitoring learner performance and tailoring (through adaptive programming) the delivery of material to meet the individual learner’s needs.

(D) Key Issues for Assessment and Evaluation

Within undergraduate bioengineering education, the adaptation of the HPL principles into the curriculum is relatively novel. Given this novelty it is important to assess if HPL-inspired innovations produce the intended enhancements in learning. Although there are a variety of ways to answer this type of question, within the VaNTH ERC we have taken an experimental approach. This approach involves:

1. *Comparisons*. To assess the “value added” of HPL-inspired innovations the performance of learners exposed to an innovation is contrasted with the performance of learners who receive traditional instruction. The A&E experts have to identify, adapt or develop appropriate comparison conditions;

2. *Devise Field Testing Procedures.* The details of data collection (e.g., pretests and posttests, control measures) and methods of implementing experimental or quasi-experimental designs all have to be tailored to the particular circumstances of the innovation.
3. *Specify Analytic Plans.* Depending upon the nature of the comparison groups that are established, measurement and statistical procedures need to be specified to minimize the influence of biases.

Main Challenges

A collaborative Team Review is needed because of the complexity of the issues that need to be addressed before implementing an HPL-inspired innovation. A main challenge for members of the Review Team is to reconcile the competing demands that inevitably arise. For example, evaluating the effectiveness of the module in enhancing learning outcomes requires the development of knowledge-based exams that can be used with students who receive the same content, but through a traditional form of instruction. A host of technical (e.g., sample size, statistical power, comparability of the exam across conditions) and practical (e.g., finding a suitable comparison group) assessment and evaluation issues need to be resolved.

However, the main advantage of the Team Review is that these competing demands are addressed in a collaborative fashion; often the final design is substantially stronger (and more comprehensive) than in its initial form.