An Information Retrieval System for Curriculum Mapping

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Abstract

We present information technology for curriculum management, balancing three needs: for teachers to take notes, coordinators to maintain consistency, and administrators to make informed decisions The technology we have developed creates portals through which teachers, curriculum coordinators and administrators access a curriculum database based on Heidi Hayes Jacobs curriculum mapping methodology. The software design specifically addresses issues of planning, developing and assessing curriculum, ranging from the individual classroom level to the broad-based planning required of upper level administrators. This technology is not intended to directly support instruction, but significantly enhances teacher and administrator management of content and assessment. An explicit social and ethical goal of this project is to address the balance of privacy and security for users as well as promoting a culture of collaboration among administrators and teachers.

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OBJECTIVES AND PURPOSE

This project is collaboration between faculty and undergraduates at The College of New Jersey (TCNJ) and staff of the Hopewell Valley Regional School District (HVRSD). It was initially supported through the auspices of the TCNJ Professional Development Network, a consortium of thirteen school districts and TCNJ. HVRSD uses a technique called "curriculum mapping" [10,11,12,14,16,19] to describe curricular activities. We are developing database and information retrieval technology to support annotation, aggregation and analysis of such maps. This technology allows us to do both highly specific and very general analysis of curriculum content, skills specification and assessment [3,6,7,13,15,22,28,29]. For example a principal could study the progression of math skills from the 1st - 5th grades, or see where in the overall curriculum Native American culture is studied. A 2nd grade teacher can make notes on how a hands-on science lab faired with a particular cohort of students and share that information with her colleague at another elementary school in the district. The key problem addressed is how to balance server side centralized data analysis and security with individual privacy in note taking and information sharing. Our evolving tools should allow administrators, teachers and parent committees varying levels of access to "released" aggregate data, while supporting individual teacher's need to keep personal notes and choose when and what to share. A critical component of curriculum mapping is the safety teachers feel in openly discussing whether their goals have been met. This must be balanced with administrators' needs to develop informed plans that assume the aggregate curriculum is indeed being implemented in individual classrooms.

We approached this problem from what would seem a natural perspective: the software developers and the school staff worked closely to define goals and objectives of the software, took care in how all constituencies would be represented in the development process, and from the very start considered the societal and cultural impact of the technology on the school environment. It became evident almost immediately that the software implementation could dominate the culture. In particular we were concerned that staff would begin to view curriculum with a bias toward how it would fit within the constraints of the software (the database framework). From the onset we required that the software support teacher and staff needs first. In particular our goal was not to make the software "teacher proof", but to establish a process by which teachers (and administrators) could proactively contribute to the iterative design and implementation of the software, as well as to its dissemination and acceptance in the school culture [2,5,8,9,30].

This project has two interwoven themes: (1) making good software that meets the needs of a collaborating constituency, and (2) enhancing and supporting the mission of a public school district. Consequently, our statement of objectives begins with a summary of the long-term goals of the school district for curriculum mapping. We then state the goals of the software development project under development at The College of New Jersey, and finish this section with the specific aims of this proposed project.

Summary of Educational Objectives

The Hopewell Valley School District's Mission Statement includes the goal to provide our students with "a comprehensive and caring educational experience… that develops the confidence and capabilities to face the challenges of a rapidly changing world." The basis for achieving that goal is a coherent, sequential curriculum that reflects essential knowledge and inspires lifelong learning. The online curriculum mapping project is designed to use the power of technology to enhance collaboration and communication among teachers for the purpose of developing or refining our curriculum and improving student achievement. Research shows that one of the most effective ways to enhance student achievement is to bring teachers together to plan, discuss, and critique curriculum and instructional practice. While the value of collaboration is known, the time and resources to bring teachers together regularly are lacking in Hopewell Valley as they are in most educational settings. Using technology to facilitate meaningful dialog among teachers can fill the gap between what we value and what we can realistically afford to provide.

Project Goals Include:

1. To create a collaborative environment in which teachers can communicate openly and in a time sensitive manner about curriculum and instruction by allowing them to share the following experiences:
    a. ongoing reflection and assessment of the current curriculum maps by analyzing the maps in light of classroom experiences and student assessments and then annotating their findings
    b. suggesting curriculum adjustments based on data obtained
    c. jointly evaluating the merit of their own and others' suggestions for revisions
    d. identifying redundancies and gaps in the curriculum through the search feature that allows teachers to construct queries that address both horizontal and vertical articulation of the curriculum
    e. discussing common themes and essential knowledge within the grade level and across grade levels
    f. researching the spiraling sets of skills and understandings as students progress through the grades.
2. To improve instructional practice by
    a. helping teachers visualize and support the connections between essential questions that guide intellectual inquiry and the assessments that provide evidence of content knowledge and skills obtained
    b. allowing teachers a clear picture of students prior curricular paths as well as levels of proficiency required in subsequent years
    c. allowing teachers online access to current research, teaching resources, and national and state standards as they construct the curriculum document and use it to guide instruction.

3. To use technology as a tool to move our thinking about curriculum design from content driven curriculum goals to thematic, interdisciplinary goals that are based on state and national standards and shaped by essential questions and assessments that inform and improve student performance.

4. To improve the responsiveness of our curriculum development process by supplementing the state's requirement of a five-year cycle of revision with an ongoing process of reflection, assessment and revision based on current data related to student achievement, expanding knowledge in the disciplines, and current research on effective instructional practice.

Objectives for Software Development

Our software development objectives are geared toward the research setting at The College of New Jersey, which is a primarily undergraduate institution. Our objective is to create a research environment in which students can participate for a short duration (typically 1 – 3 semesters.) We explicitly develop a culture that utilizes the energy, talents and unorthodox viewpoints of undergraduate students. From the onset, the Hopewell Online Curriculum Mapping project has afforded our students with the opportunity to critically analyze the traditional database design methodology. Two key issues emerged as a result of our process to date:

1. Traditional data entry and analysis techniques for databases and user interfaces would not meet the needs of the school district without creating serious compromises on district goals. Off-the-shelf technology only provides the framework for data entry, but does not facilitate teachers' development of reflective skills. We must ask, "How can we build user interfaces that proactively support teacher reflection on curriculum?"

2. Data analysis led to major insights into the strengths, weaknesses and potential of the information representations articulated by the Hopewell staff and provided guidance for the district on what was working well, and what wasn't in their mapping process even before data entry began. Such symbiosis in the data analysis process is not unique to the school. We posit that malleable user interface design will be crucial to effective technology integration.

It became abundantly clear that the software development process requires close collaboration between the HVRSD staff and TCNJ student software developers. Consequently the software development goals are as follows:

1. Database design is iterative. We must anticipate that the database schema established initially is fundamentally incomplete, and must be subject to change as new needs and insights emerge. All software development must account for this phenomenon.

2. Tools for data entry will be evolving as well. Our goal is to define tools that provide users with proactive support in facilitating district curriculum goals. User interface implementation occurs within a rapid prototyping framework, where components can be easily modified and adjusted "on demand."

Communication with users must be ongoing, efficient, and responsive to facilitate accurate accounting of needed change, and implementing such change effectively.

1. To develop sound theory of cultural integration, systematic analysis of IT artifacts must occur through careful documentation of use as well as reflective analysis by users.
2. Regardless of the fact that the software is in a "beta" test stage throughout this project, the teachers who use it must have confidence that it is stable. Thus, while we are working in a research and development mentality, we must support commercial level access to a working version as well.

SIGNIFICANCE

The significance of this work is that it explicitly addresses the ethical question of the balance between individual privacy, group collaborative needs, and institutional security. Much current technology, especially that which supports classroom management, has evolved to support group collaboration, and accountability over individual privacy. There is a national mandate to strengthen all institutional security. Our focus stresses balance between these competing needs. Although software is available for teachers to develop lesson plans and to share materials it is not well integrated with database systems that specifically support curriculum mapping or curriculum planning in general. Such software implicitly assumes that information to be shared is in a completed form (e.g. a lesson plan, or scope and sequence statement)[4,26]. Our approach acknowledges that all curriculum development and implementation is work in progress, and the purpose of curriculum guidelines is to clearly outline expectations for student learning while allowing school staff to customize and personalize teaching and learning as they demonstrate through articulated assessments that they are achieving mandated standards.

This work has the potential to have significant impact on how teachers, curriculum coordinators and administrators manage information related to curriculum. Assuming our technology creates a safe environment in which staff can comment honestly on curriculum and its implementation, the technology will provide a vehicle through which administrators can make informed decisions of a global nature. It will provide coordinators with insight into how curriculum needs to be adjusted because of documented success and identified problems in the classroom. For teachers this tool has the potential to provide a means through which they can become truly reflective about curriculum implementation, and collaborate in a manner that is supportive of individual teaching styles and creativity [17,18,21].

We posit that the consequences of technology can be predicted when there is deliberate care taken to develop solutions that meet user needs especially with respect to the question of trust. This extends beyond a balance between system security and privacy, and plays directly into questions of how the stakeholders in a social setting trust each other. For an IT artifact to become truly imbedded in the genuine activities of a constituency there must be established trust of the technology as well as trust toward those who mediate the implementation of the technology.

PERSPECTIVES AND THEORETICAL FRAMEWORK

Curriculum mapping was developed by Heidi Hayes Jacobs [10,11,12,13,14,15,16,17,18, 19]. It provides an innovative way for teachers and administrators to establish curricula both for particular grade levels and across schools and districts. Traditional curriculum committees create a comprehensive list of goals and objectives related to the topics to be studied within the discipline. Curriculum mapping identifies the relationship between curricular goals and objectives, activities that can meet those objectives and assessments to measure outcomes. Teachers reflect on past experience to build a personal map. An aggregate map for a district is formed from the individual maps. Typically such maps are developed through simple word processing techniques. Ideally teachers develop maps as an ongoing part of their classroom management.

In Hopewell the aggregate maps are developed and modified during a few face-to-face collaborative sessions per year. The intent of a map is to chart real activity. However, because teachers only modify aggregate maps occasionally, real data on individual experience is implicit rather than explicit in the formal maps. Individual teachers may make handwritten annotations to their paper copies of the aggregate maps. This information is used to modify the district maps at the meetings. This compromise approach to Hayes ideal is necessary because of the severe limitations on teacher time -- which is a reality in districts nation-wide[1]. Furthermore, the district chose to focus on aggregate maps as the basis of longitudinal data analysis rather than individual teacher maps. This decision occurred long before automation was considered because the district staff assumed that teachers would have to define aggregate maps collaboratively. It is clear in hindsight that the aggregate maps could not be generated automatically from individual maps, nor could district administrators use multiple maps for a grade level as the basis for longitudinal data analysis.

A number of systems [4,26] are now available that provide basic database entry and access for curriculum mapping. These systems have an "MS Access" look and feel that assumes teachers are fully able to enter reliable information using standardized keywords, and that there is sufficient expertise to frame longitudinal questions as formal database queries. Furthermore, these systems rely on standard views to present results. For example, the view of the 3rd grade map presented to the public is identical to that presented to 3rd grade teachers. There is no facility for truly private information for an individual or group, thus the third grade teachers cannot hold a private conversation about potential curricular change. Finally these systems either do not support the notion of an aggregate map, or do not clearly delineate between individual and aggregate maps. They presume that aggregate map development follows Hayes' model exactly: that teachers first develop individual maps in detail that are then aggregated with automatic assistance. Practically, this is simply not possible in the Hopewell setting given teacher time constraints. This is a universal problem for public school districts. On the positive side, these systems do link to national standards and in some instances state standards, and they allow users the ability to connect recommended resources to the maps.

The Hopewell staff was particularly concerned about two shortcomings (1) how to allow teachers to annotate maps without changing the aggregate map developed in collaboration and (2) how to pose the questions they want to ask without knowing a

database query language. The solution is two-fold. First, we needed to develop a database system that explicitly defines the roles of various types of users. Second, we view the problem as one of information retrieval from a digital library using state-of-the-art techniques. This latter perspective is particularly compelling because the problem of library construction is strikingly similar to map development with a special twist. Digital libraries are typically assumed to contain completed publishable material. Our approach assumes that the information will be continuously evolving and at many stages of completion, with not all of it ready for "publication."

Pedagogically, the collaborators on this project view public education as essential to the democratic process. From this perspective highly skilled teachers are given the resources and support to make meaningful decisions about how to educate each child to become a thoughtful, productive citizen. To that end curriculum development and implementation is an ongoing, dynamic process. Teachers should be able to adjust to students' needs, comment on successes and identified needs, and provide administrators with real data for curricular assessment that complements and enhances standardized measures. Consequently we view information access as critical to decision making at all levels. All stakeholders, teachers, administrators, parents and the community at large must have an accurate picture of the effectiveness of learning in the classroom. This requires information that is accurate, and that specifically addresses the relationship between curricular goals, content, and assessment.

With regard to process, our approach is inherently collaborative, with a clear focus on individual rights and responsibilities. Our process to date has also been one of addressing questions of use and mistrust of and expectations and misconceptions about technology for curriculum management. From the onset we have asked questions related to how our system would be accepted by individual teachers, how established procedures and interactions among groups would be respected, and how collaboratively produced artifacts would be respected and protected.

RESEARCH METHODS AND RESULTS

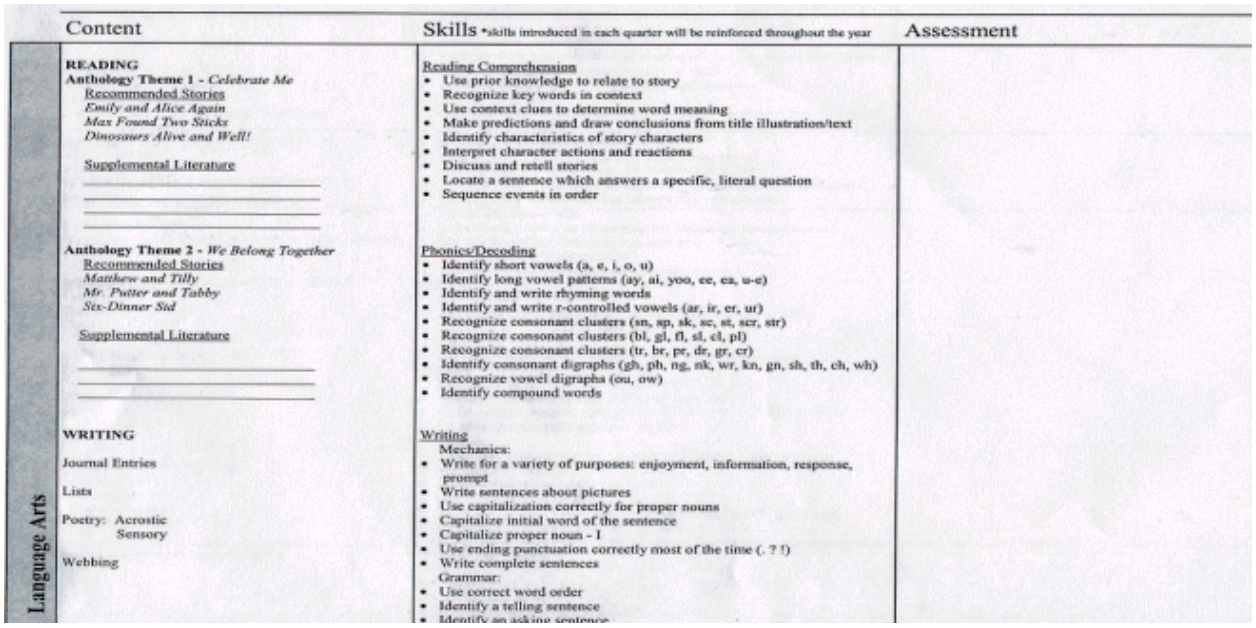
Research methods for this project have combined good software engineering practice with qualitative data analysis. Because this process was iterative spanning three academic years, methods and results are reported chronologically. We stress that it was the close and constant collaboration between the TCNJ software developers and the HVRSD staff that provided a vehicle through which curricular change has taken place.

Over the past three years members of the HVRSD staff have met with faculty from TCNJ to articulate need, discuss design solutions and evaluate prototype systems. The HVRSD staff played the role of "client", articulating need based on personal insight as well as leading systematic discussion with a broader-based cohort within the district. The TCNJ faculty member (Ursula Wolz) played the role of "project manager" assigning specific prototype development tasks to undergraduate researchers participating in upper level courses for credit. Iterative refinement consisting of prototype development and testing continues to be critical to successful development. To date we have a beta version available for use by staff in the district [29]. Because of the proprietary nature of the curriculum implemented, we cannot allow pubic access to the current data. We are

developing a guest view of the software system that will not be based on the actual Hopewell curriculum. See http:/hopewell.tcnj.edu/ in fall 2004 for more information. Visits to our site are also welcome.

Pre-Database Curriculum Mapping

Curriculum mapping at the K-5 level has been an active enterprise in Hopewell over five years. Because of time constraints, teachers met each summer to develop an aggregate map for each grade based on individual notes taken during the school year. These maps were word-processed by a district clerk, and professionally printed on 8x36in paper. A portion of a map appears in Figure 1.



	Content	Skills *skills introduced in each quarter will be reinforced throughout the year	Assessment
Language Arts	**READING** **Anthology Theme 1** - *Celebrate Me* Recommended Stories *Emily and Alice Again* *Max Found Two Sticks* *Dinosaurs Alive and Well!* Supplemental Literature **Anthology Theme 2** - *We Belong Together* Recommended Stories *Matthew and Tilly* *Mr. Putter and Tabby* *Six-Dinner Sid* Supplemental Literature **WRITING** Journal Entries Lists Poetry: Acrostic Sensory Webbing	Reading Comprehension • Use prior knowledge to relate to story • Recognize key words in context • Use context clues to determine word meaning • Make predictions and draw conclusions from title illustration/text • Identify characteristics of story characters • Interpret character actions and reactions • Discuss and retell stories • Locate a sentence which answers a specific, literal question • Sequence events in order Phonics/Decoding • Identify short vowels (a, e, i, o, u) • Identify long vowel patterns (ay, ai, yoo, ee, ea, u-e) • Identify and write rhyming words • Identify and write r-controlled vowels (ar, ir, er, ur) • Recognize consonant clusters (sn, sp, sk, sc, st, scr, str) • Recognize consonant clusters (bl, gl, fl, sl, cl, pl) • Recognize consonant clusters (tr, br, pr, dr, gr, cr) • Identify consonant digraphs (gh, ph, ng, nk, wr, kn, gn, sh, th, ch, wh) • Recognize vowel digraphs (ou, ow) • Identify compound words Writing Mechanics: • Write for a variety of purposes: enjoyment, information, response, prompt • Write sentences about pictures • Use capitalization correctly for proper nouns • Capitalize initial word of the sentence • Capitalize proper noun - I • Use ending punctuation correctly most of the time (. ? !) • Write complete sentences Grammar: • Use correct word order • Identify a telling sentence • Identify an asking sentence	

Figure 1: Example of a Paper Map

Stage 0: Design (2001-2002)

An initial articulated goal for the database was to allow rapid reorganization of the content, in particular to "map" particular content such as "phonics", "rocks and minerals", and "expository writing". An initial schema design implemented partially as a database in 2001 included a very rich relational schema that anticipated sophisticated data analysis. It also highlighted the data complexity of the printed maps. In particular, the attempt to enter data showed significant inconsistencies in the teachers' interpretation of the terms "theme", "content", "skills", and "assessment". This can be seen in Figure 1 through the absence of "assessments," which are often implied in the combination of content and skills.

When the curriculum specialists were approached with this problem, a second problem emerged with regard to data entry. Individual teachers could not modify existing maps, even to correct them without group consensus and supervisor approval. Consequently, the software design team proposed incorporating annotation features into the database, so that teachers could propose changes. A prototype for such annotation was also developed in 2001, and was quickly approved by the district curriculum supervisors.

It also became clear that the long-term goals of curriculum analysis could not be met until the data, the curriculum maps themselves, were clean. But the maps couldn't be cleaned until the teachers were able to view and annotate the maps on line.

Stage 1: Evaluation of Prototype (2002-2003)

The schema design was streamlined to focus on data entry with the simplified goal of displaying a window with the same look as the paper maps. A crucial component of this version was the need to provide means by which teachers could annotate content and skills. This version was implemented in spring 2003. An example of the standard view of a map is shown in Figure 2.

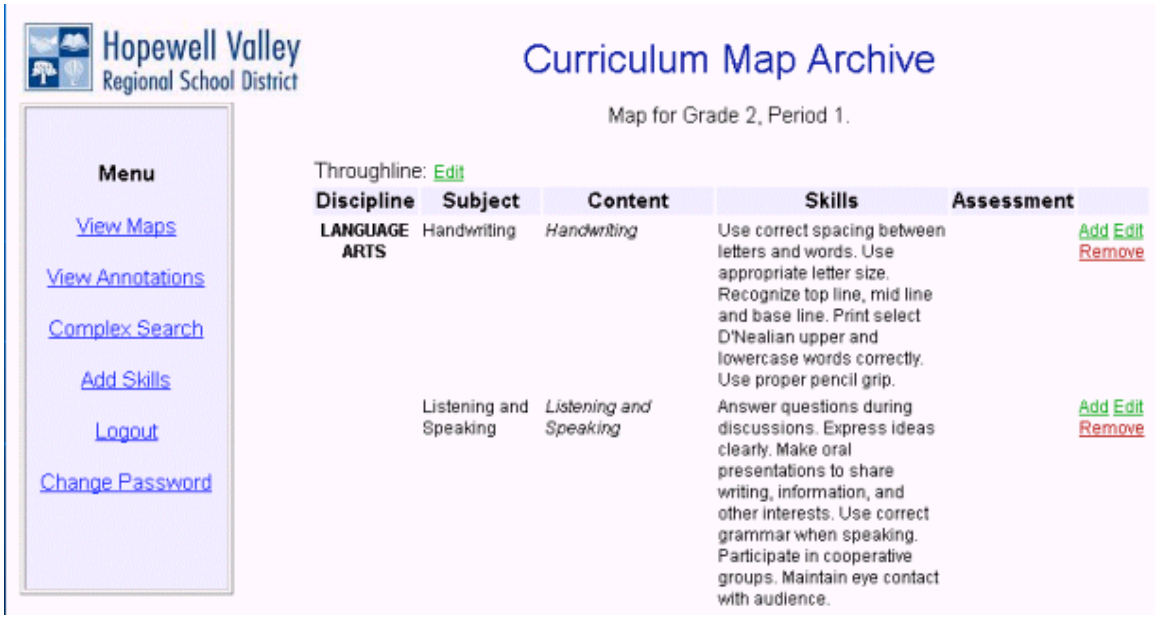


Figure 2: Example of an On-line Map View

This version distinguishes between two types of users: administrators who have editing rights and teachers who have annotation rights. Teachers can mark annotations as public or private. Only the teacher who made an annotation can view his or her private annotations.

Our goal from the onset was to provide query responses in a form that did not require users to master even a limited query language. Consequently this version uses a "Wizard of Oz" technique through which to ask questions. These questions are sent via email to a

TCNJ student researcher who constructs an SQL query and develops a customized report. The input screen is shown in Figure 3.

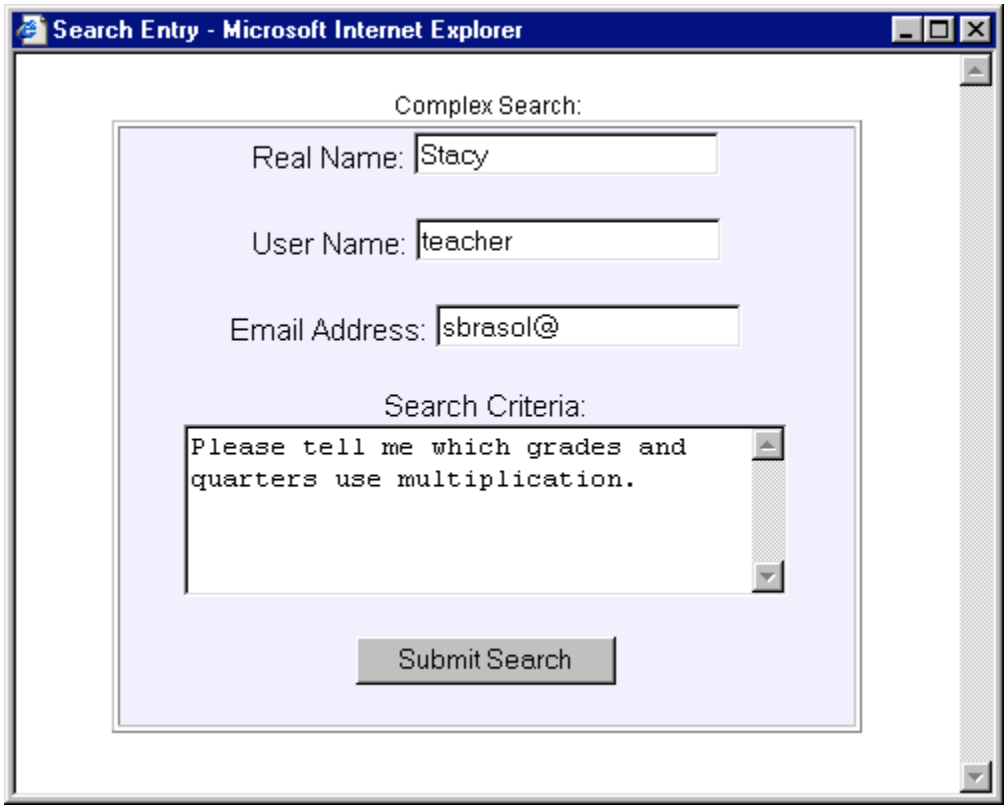


Figure 3: The Query Input Screen

Review of this version by district supervisors occurred in spring 2003. It quickly became evident that a series of workshops would be required to (1) show teachers how to use the interface, and (2) evaluate the next steps in how this tool could be effectively used for curriculum management and innovation. The intended goal of the workshops was to do minor modification to the curriculum maps in order to standardize terminology and create consistency in entries in "content", "skills" and "assessment." As will be seen, at the end of the of the 2004 academic year we are instead poised to provide support tools for consideration of major curriculum reform. We view this as a very important outcome of this work.

The tools created by the TCNJ team provided a vehicle for analysis, discussion and proposed innovation. An open atmosphere of collaboration and honest assessment was established. The teacher's criticism was focused on the tools rather than on their own and each other's work. The teachers were encouraged to articulate their concerns, and in the process they articulated their very real need for a better understanding of theme-based curriculum development and its relationship to actual content, skills and assessment. There is still a very real difference between articulating a concept and "putting it in the computer" and writing it on a piece of paper. We saw that the power of the technology

was not in administrators' ability to analyze the result of teacher input, but rather in how it could foster real focused discussion among teachers to promote and embrace curricular change. The remaining paragraphs describe the process in more detail.

Stage 2: Articulation of Views (2003-2004)

During the academic year 2003-2004, HVRSD held three teacher in-service workshops focused on curriculum mapping, innovation and analysis. A cohort of thirteen teachers from three elementary schools participated. On average 1.8 teachers represented each grade, with eight teachers representing grades K-2 and five teachers representing grades 3-5. Three teachers are "multi-age teachers" with classes of students who would normally be 1st, 2nd or 3rd grade, and one reading recovery teacher works primarily with K-2 students.

During the first half-day workshop in October 2003, the database was demonstrated to the teachers, and they were given an opportunity to make annotations. TCNJ and HVRSD representatives initiated two off-line discussions. The TCNJ group presented the problem of data anomalies, both in concept (e.g. whether something was a skill or content descriptor) and in terminology (e.g. "time", "time and money", "currency".) The HVRSD supervisors then led a discussion of conceptual issues on a broader scale, specifically the relationship between themes, enduring understandings, concepts, skills and assessments. The teachers as a group concluded that the focus for the next session should be on how to articulate themes and assessment. The mandate to the TCNJ development team was to stabilize the database, provide easy mechanisms to notify maintainers that the system was down. They were asked to develop designs for alternative views of the map that would support expression of theme, enduring understandings and the distinctions between content, skills and assessment.

A full day workshop held in March 2004 was dedicated to developing a process for articulating themes and implementing them as content, skills and assessment. The TCNJ team participated in the exercise keeping notes on how the process that emerged could be captured in an on-line format. At this juncture the teachers began to understand the degree to which the current maps needed to be modified beyond superficial concerns for terminology. Further, as a result of curriculum analysis and discussion that occurred during the months since October, it was evident that data cleaning was insufficient. The district articulated the need to consider real thematic-based revision. An outcome of this session was the articulation of the need for a "chat room" through which teachers could discuss curricular changes that provided focus on theme-based innovation, rather than skills-based change. This is a significant outcome of this work.

The TCNJ team came to the conclusion that the current annotation facility should be enhanced in order to allow teachers to more easily view and track annotations on a particular topic. The dynamic and fleeting nature of dialog in a chat room would not meet the need to provide a persistent record. Similarly, a temporal-based list-serve does not provide sufficient organizational structure to view annotations from multiple perspectives.

A third full day workshop was held in April 2004. This was a mock trial run of the mechanics of supporting on-line discussion about annotations. During the previous months the TCNJ team created a number of standard views to aggregate and organize the annotations so that on-line analysis of annotations would be more convenient for the teachers. At this workshop teachers were given specific tasks to (1) annotate content, (2) review the annotation of others and then annotate again, and (3) where necessary construct questions (requiring database query) to address issues raised in this annotated "discussion." During this session TCNJ members translated questions into database queries and provided "real time" answers.

During this session the teachers produced 154 annotations, modifying 1/3 of their initial set. They also produced 13 questions, 10 of which were immediately answered via TCNJ member constructed SQL queries. The system-side outcome of this workshop was affirmation that the underlying database schema is sufficiently robust to support the current state of curriculum mapping in Hopewell. It is very evident however, that a plethora of alternative views would significantly enhance teacher ability to think about change to the curriculum.

Outcomes

Whereas we began with the assumption that questions to the database would be primarily natural language in nature, the results of the three workshops indicate that there are standard views that capture most questions. In particular the primary focus of queries involves vertical views of the data (e.g. "when is this being taught.?") We are in the process of designing a viewpoint that will specifically address not only the ability to view vertical relationships, but reorganize the placement of content based on this view. A four-day summer workshop will be held in late June to test this approach, immediately after the teachers participate in training on theme-based curriculum.

Secondary outcomes of the iterative process include:

- The ability to attach specific curricular ideas to content/skill entry in the database. Teachers can either upload a file, sharing their own materials, or provide an html link to public materials
- The ability to link content to the New Jersey State standards. We anticipate that this will become a powerful vehicle for administrators.

Summary of Results

To date we have a software system in place that distinguishes between five types of users: system maintainers, teachers, administrators, coordinators, and visitors. (At present only system maintainers and teachers are turned on.) We define information in the maps as belonging to an aggregate map or being part of an annotation to a map. This distinction solves the problem of maintaining multiple maps of the same data. Further, in order to support curriculum change as it proceeds through the approval process in the district, we now support the distinction between the "official map" and a "draft map."

Individual teachers' maps are defined as their annotations to the aggregate map for their grade. Links to curricular materials related to content in a map are considered to be

annotations. Annotations can be public or private. Visitors may post comments via an email interface, but do not own information that is considered part of the database.

The user roles provide both security and privacy. They also implicitly support collaboration based on who is allowed access to and modification rights to specific information. System administrators have full privileges and can create maps, edit existing maps and manage user accounts. But they cannot view an encrypted private annotation. Administrators can view maps, define accessibility to maps for types of users, and ask questions of the database. Coordinators have all of the accessibility of administrators, but can also edit specifically assigned aggregate maps. Teachers can view aggregate maps and annotate them either publicly or privately. They can also link curricular materials to aggregate maps. Visitors (e.g. parents, school board members) can view aggregate maps that have been made "public", and although they cannot annotate them in the same manner as teachers, they can register general "comments" through an email interface. Note that a single user may have more than one role, for an example a principal in a school may be a coordinator and a teacher with respect to the database.

IMPLICATIONS FOR PRACTICE

The relational database we constructed allows us to create a potentially infinite variety of views of the information defined in the aggregate maps with annotations. The addition of text retrieval techniques provides a significant degree of freedom to extract information. One practical outcome to date is the ability to aggregate the annotations to a particular map. For example, when the grade 1 teachers district-wide meet, they are provided with all of their public annotations organized by content area. This simple automatic re-organization means that they can review each other's comments before the meeting, and come to a synthesis of potential change more rapidly.

We already see outcomes with regard to map development and use. The simple process of entering the existing maps into the database has led to revision of terms, organization of content and more focused discussion on the distinction between skills and assessment. HVRSD staff suggested that we link curriculum materials to content areas in the map. This was technically simple to include, and provides a degree of collaboration that was not initially envisioned by the administration. To date, mapping is implemented in grades K-5, including multiage maps for grades 1-2 and 2-3. Automation appears to be an inducement to middle and high school teachers and we anticipate that maps for 6-12 will be implemented directly on line, beginning with the 6-8 maps next year.

This work has the potential to have significant impact on how teachers, curriculum coordinators and administrators manage information related to curriculum. Assuming our technology creates a safe environment in which staff can comment honestly on curriculum and its implementation, the technology will provide a vehicle through which administrators can make informed decisions of a global nature. It will provide coordinators with insight into how curriculum implementation needs to be adjusted because of documented success and setbacks in the classroom. For teachers this tool has the potential to provide a means through which they can become truly reflective about curriculum implementation, and collaborate in a manner that is supportive of individual teaching styles and creativity.

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