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Web-based Performance Support System for School-based Curriculum Development: SBCDSS

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Abstract. School-based curricula are seen as the important strategy to facilitate educational reforms and are spread in many countries, especially in Asia. However, the efficiency of developing and implementing school-based curricula in most schools are very low because the tasks those need to be dealt with are very complex and difficult. How to develop and apply the electronic performance support system (EPSS) to simplify the complexity and to improve the efficiency of school-based curriculum development and implementation becomes the important research and practical issue. In our prior work, a web-based computer-assisted instructional planning system, IPASS, was designed to provide a set of tools for individual teachers efficiently designing instructional plans. However, the system was dedicated for the design phase of curriculum development and did not support for all participants in different levels of school-based curriculum development, working on curriculum analysis, design, implementation and evaluation. This study designs and develops a novel web-based performance support system, SBCDSS, to assist the whole process of school-based curriculum development and implementation. The proposed system has been adopted in an elementary school in Taiwan and has received useful feedback regarding the usability and performance support for SBCD. Evaluation results and possible future work are discussed herein.

1. Introduction

The major features of school-based curriculum development (SBCD) involve decentralized management and shared governance of curriculum development. SBCD is seen as a significant strategy for facilitating educational reform and teacher professional development in most countries [2, 3, 6, 10], especially in Asia currently [5]. During implementing SBCD, although schools possess decision-making power in curriculum development, they are often not as efficient as expected due to the complexity and difficulty of many relevant tasks. For instance, Marsh et al. [6, p.49] presented a matrix with three dimensions of SBCD, the type of activity, people involved, and time commitment, generating 64 variations of development theories and tasks. Considering the technical rather than the sociopolitical perspective, a complete school-based curriculum is constructed from various mutual dependent sub-curricula, such as the class, subject and grade curricula [11]. Different sub-curricula have different features and goals, and involve teachers at different levels. Articulating and integrating different sub-curricula, ensuring that whole school-based curriculum conforms to the criteria of continuity and sequence, is important but difficult. For example, during curriculum developments, the curriculum developers must collect, accumulate and integrate volumes of documents and lesson materials designed by teachers (the curriculum practitioners to integrate and evaluate the whole school curriculum). Moreover, SBCD involves many tasks, such as coordination, implementation, evaluation, and management, which are troublesome for curriculum developers at each level.

Electronic performance support systems (EPSS) have recently become a popular means of supporting curriculum development. As a computer-based system, EPSS improves individual job performances and organizational competitiveness by providing an on-demand environment with various tools and software applications. The aim of EPSS is, according to Gery [18], to provide whatever is necessary to generate performance and learning at the moment of need. EPSS has been applied to curriculum development since the early 1990s. Nieveen & Van den Akker [19] explored many available systems and found that EPSS (related studies are described in Section 2) had many potential applications when applied to curriculum development. However, few works are concentrated on developing school-based curriculum, but also many disadvantages and special requirements (see section 3). Moreover, only a few empirical results are available to demonstrate the effectiveness of an EPSS in practice [19]. This study designs and develops a web-based performance support system (see section 4) to assist SBCD by providing various developer

tools for a three-level school hierarchy in four development processes. The characteristics of the support system are:

- quantitative and qualitative analysis support;
- collaborative curriculum design;
- curriculum implementation support for both teachers and students;
- formative evaluation for each curriculum development stage, and
- communication aids with categorized discussion boards.

The system has been constructed and adopted in an elementary school in Taiwan and has received positive feedback regarding the usability and performance support for SBCD. Section 5 discusses the evaluation results and possible future research work. The rest of this paper is organized as follows. Section 2 introduces current status about EPSS in curriculum development. Section 3 then describes the system requirement of the proposed system. Next, Section 4 elaborates the design and development of proposed system based on the requirement analysis. Additionally, Section 5 describes the system evaluation while applying to an elementary school. Conclusions are finally drawn in Section 6, along with areas for future research.

2. Electronic Performance Support System for curriculum development

An electronic performance support system (EPSS) provides integrated information, advice and learning opportunities to enhance user performance [18]. EPSS can provide job aids, communication aids and learning facilities [9 & 20, p.20]. EPSS initially serves as on-the-job training in an organization, and improves the cost-effectiveness of training efforts. Then the communication and job aids are considered in EPSS after the advancement of communication technology. Among the merits of an EPSS include improvements in performance learning process efficiency [20, p.22–23], and reduced cost of transferring the knowledge and skills to the actual task performance [18]. Nevertheless, an EPSS need not be fully electronic. People using an EPSS can use other non-electronic support by referring to the stored resource information [21]. The EPSS cannot replace people's thinking and creativity, but instead simply improves working efficiency.

EPSS has been applied in curriculum development since the early 1990s. Nieveen & Akker [19 & 20] reviewed curriculum development systems developed before 1996 considering levels of focus, supported tasks, types of support and intended user group. Each system has its own characteristics for certain user groups (experienced or non-experienced developers) on particular

tasks by providing certain types of support (like a toolbox, cookbook, or automatic washing machine). Like EPSS, a computer-supported curriculum development system improves task performance. However, most such systems are still based on assumptions, and lack empirical results [20]. Additionally, some studies have applied EPSSs in an educational context to enhance teachers' or students' knowledge acquisition and performance improvement. For instance, McGraw [7] integrated artificial intelligence, hypermedia and computer-based training to develop an EPSS to enhance user performance. Barker and Banerji [1] introduced the concept and methodology of EPSS design. Van Schaik et al. [12] designed and implemented a quantitative research method for a psychology degree course. Wild [13] designed a lesson planning system as an educational performance support system to support novice teacher-education students in learning and in the complex task of lesson planning.

CASCADE (Computer ASsisted Curriculum Analysis, Design and Evaluation), a renowned series of studies of computer supported system for curriculum development, was widely experimented in four regions, the Netherlands (original CASCADE), southern Africa (CASCADE-SEA), China (CASCADE-MUCH) and Indonesia (CASCADE-IMEI). Each study used an EPSS product and was tailored to support different elements of the curriculum development process in various contexts. The original CASCADE provides explicit guidelines and procedures on the curriculum formative evaluation [20]. CASCADE-SEA studied the feasibility of applying CASCADE to teaching science and mathematics [8]. CASCADE-MUCH provided a wizard-like tool for developers of multimedia biology course materials [22]. CASCADE-IMEI studied the use of the Internet in supporting pre-service students learning realistic mathematics education [23]. McKenney et al. [9] examined the features of these systems, concluding that the series provided job aids, learning opportunities and communication aids to help curriculum development for different levels (micro [classroom], meso [institution], and macro [system]) of target users. The CASCADE systems by offering a systematic approach and explicit structure, helping developers design elaborate and internally consistent curricula. All the CASCADE systems except CASCADE-SEA provide tools for the micro-level, the teachers, in selecting and adapting instructional materials for their own classroom context. CASCADE-SEA has an apparently similar support level to this study which concentrates on the school (meso) level.

In summary, the above performance support concepts and technology-applied curriculum development designs can be concluded as:

1. the performance will be improved if appropriate information and just-in-time tools are available;

2. formative evaluation during curriculum development is important;
3. a common working platform (information system) can play as an important role for coordination and management; and
4. teachers' interests in curriculum development will be encouraged while they design the instructions with the support system.

However, a school-based curriculum is different from the above mentioned curriculum that comprises only one or two subjects, which must integrate various subjects. Additionally, a school-based curriculum cannot be considered and operated at just one level. A school-based curriculum should be based on national education policies, planned to suit the school needs, and flexibly implemented in the classroom. The organizational structure for SBCD within a school can be split into three sub-levels, class, grade, and school, to address different curriculum configurations. Each sub-level concerns different curriculum organization criteria and should collaborate with each other to construct the whole curriculum.

An Instructional Planning Assisted SyStem (***IPASS***; URL: http://eduplans.educities.edu.tw/) [4], which is a web-based EPSS for instructional design in classroom (micro) level, has been developed. It emphasized the design of instructional plans for individual teachers by providing template-based tools with co-design mechanism to help collaborative design work. Between 2002 and 2004, the system helped more than 20,000 teachers to design in excess of 12,000 instructional plans. IPASS also was utilized to support pre-service teachers' learning how to design instructional plans and with fruitful results [25]. The usibility and performance enhancements were proved by the positive feedbacks from our survey. However, the system was dedicated for the design phase of curriculum development and did not support for all participants in different levels of SBCD, working on curriculum analysis, design, implementation and evaluation. This study creates ***SBCDSS***, which massively extends and modifies the functionality of IPASS to support the whole process of school-based curriculum development, across the class, grade and school levels. ***SBCDSS*** is the acronym of School-Based Curriculum Devleopment Support System. The main featured functionalities include query and statistic tools for curriculum analysis and evaluation, collaborative design mechanism for curriculum design, e-Learning system for curriculum implementation, rubric table for curriculum evaluation, and categorized discussion boards for communication. The following sections present the requirement analysis, system design & development, and evaluation of the system.

3. Requirement analysis

A curriculum denotes the content taught in schools and the standards taught for each subject. Instruction refers how teachers teach the content and the instructional methods adopt to motivate children to learn. However, curriculum development activities generally involve instructional design and curriculum content. Therefore, the term "curriculum development" herein includes "instructional development". The instructional design (ID) model can be extended and adapted for curriculum development.

Ideally, SBCD should empower teachers design the curriculum and select the teaching materials, whereas the administrators (including the principal) support coordination, management and conduct of curriculum development, and hold the in-service training courses or workshops. Therefore, the teachers and administrators are the main target users of the proposed system, ***SBCDSS***, and of the requirement analysis. Different countries have different educational cultures and organizational philosophies as well as SBCD requirements. The requirements analysis is based on the situation in Taiwan, but most requirements correspond with those of schools in other countries. The following subsections first explore the tasks involved in SBCD. The organizational structure of SBCD and the tasks of each level are then discussed to clarify how the system could support various tasks.

3.1. Main tasks of SBCD

Although a school-based curriculum can be developed in many ways [14-17], the tasks of SBCD always include the five main activities, which are the analysis, design, development (or production), implementation and evaluation (ADDIE) [14]. In the systematic and iterative method, the five activities can be structured as a cyclic and long term process, which is gradually enlarged in scale or scope from class to school level. The tasks of the five activities are discussed and are concluded as the following phases, based on interviews with many school administrators and teachers. The preliminary functionalities of ***SBCDSS*** are also discussed.

Phase 1. Analysis: The overall curriculum framework is analyzed according to the prospect for students, school geographical environment and socioeconomic background of all students. This stage outputs the curriculum objectives which direct and affect the development emphasis of following tasks. The developers need to analyze previous instructional plans and implementations to draw up suitable curriculum objectives. Therefore,

SBCDSS must be able to provide developers with the searching, statistical and analytical checklist tools to improve developers' performance.

Phase 2. Design: The developers then design the instructional plans concerning the teaching objectives, material selection, instructional steps, exercises and assessment instruments according to the overall curriculum structure and objectives. ***SBCDSS*** must be able to provide developers with systematic design templates to guide the developers designing curriculum in a unique documentation format for easy sharing, collaboration and management.

Phase 3. Development: The learning materials and instructional instruments are created based on the design phase. However, the developers can also prepare materials by selecting from or adapting existing materials, which can be paper-based documents, manipulative instruments, or digitized materials. Many commercial digital material creation tools are available to create authoring materials, so this phase is generally combined with the design phase. ***SBCDSS*** must be able to simply provide developers with links to material files or shortcuts to launching related authoring tools.

Phase 4: Implementation: The designed curriculum should be implemented by the appropriate subject teachers to prove it is feasible and conforms to the stated objectives. Thus, the main task of this phase is to implement the curriculum according to the instructional plans designed in the previous two phases. Teachers generally have to note down anything that may improve the curriculum and keep track of students' learning achievements for further evaluation in the following phase. Therefore, ***SBCDSS*** must be able to provide an instructional note-taking tool for teachers to record instructional introspection or students' response, and can also construct an e-learning platform for students accessing the designed materials, discussing the lessons or carrying out various online learning activities.

Phase 5. Evaluation: This phase is divided into two methods called formative and summative evaluation. Formative evaluation is performed in Phases 2 and 3 to verify the curriculum organization criteria such as continuity, sequence, integrity and adaptability. Summative evaluation is performed after implementation for the review of the whole curriculum including the criteria of curriculum organization and instructional outcomes. ***SBCDSS*** must be able to provide developers with checklist, conditional searching, assessment tools to evaluate student achievements and statistical tools for quantitative evaluation.

Although these five phases appear to be followed linearly, Phases 2 and 3 could be followed iteratively to rapidly generating the curriculum prototypes. The (formative) evaluation phase can also be applied to this iterative process to review and revise the curriculum prototypes.

3.2. Organizational structure of SBCD

McKenney et al.'s [9] curriculum development classification emphasizes SBCD on the meso and micro levels. Since almost all teachers have to be involved in curriculum development, the integration, coordination and management tasks are not easy to conduct. An intermediate level, the grade level, needs to be added between the meso and micro level to push the tasks forward smoothly. Therefore, the participants of SBCD (or the target users of ***SBCDSS***) are layered into three levels, school, grade and class. This structure matches that of the school's organization. Each level has its own main tasks and corresponding actors in the SBCD (see Table 1).

Table 1. Organizational structure of SBCD

Level	Tasks	Main actors
School	• Analyzing previous courses and implementation outcomes • Designing the whole school's curriculum framework • Evaluating curriculum continuity, sequence and adaptability	Members of the SBCD School Committee
Grade	• Analyzing previous grade courses and implementation outcomes • Designing curriculum plans (preliminary plans) • Evaluating curriculum integrity and adaptability	Members of the SBCD Grade Committee
Class	• Analyzing previous instructional plans and implementation outcomes • Designing instructional plans • Developing, selecting and adapting materials • Implementing instructional plans • Evaluating curriculum adaptability	Individual teachers or teaching groups

The school level establishes an SBCD School Committee, whose members mainly consist of the principal, administrative directors and representatives from each subject and grade. The committee designs suitable subject curriculum in line with the school's development vision, prospects, location and socioeconomic background of all students. Additionally, the committee analyzes previous courses and their implementation, designing a framework for the entire school curriculum. The committee later explains the design of

the curriculum framework to the entire faculty to reach a consensus and collect suggestions for improvement. Additionally, the committee then assesses the continuity, sequence and adaptability of the course when the curriculum is performed or ended.

In the grade level, all homeroom teachers and subject teachers for each grade level meet regularly as an SBCD Grade Committee. The committee designs a curriculum plan (preliminary plan) for each grade based on the school's entire curriculum framework and previous course designs and implementation. These curriculum plans are shared among all teachers. Each grade level curriculum is evaluated based on whether the courses are well integrated.

At the class level, individual teachers, either working alone or in cooperation with other teachers, design the detailed instructional plan and develop the teaching materials. The teaching materials can also be selected or adapted from existing materials. The teachers can then evaluate the usability and adaptability of the instructional plan and the teaching materials based on the implementation and teaching results.

In summary the above, the three levels all involve analysis, design, development and evaluation. The class level moreover requires the implementation phase. Each level's members have to work together, communicate and coordinate to give the curriculum continuity, sequence, adaptability and integration.

4. System design and development

The system was developed by the prototyping approach for iterative processes and improvement. ADDIE can be simplified as the ADIE model by integrating the design and development phases as the design phase based on the analysis of SBCD tasks discussed in Section 3.1. Additionally, since all participants need a common communication platform, a communication module is added. Thus, the proposed system, ***SBCDSS***, is composed of five modules: analysis, design, implementation, evaluation and communication. Each module offers the users in different levels tools to help them accomplish the tasks. The system structure is shown as Fig. 1, and the detailed functions of each module are described in following subsections.

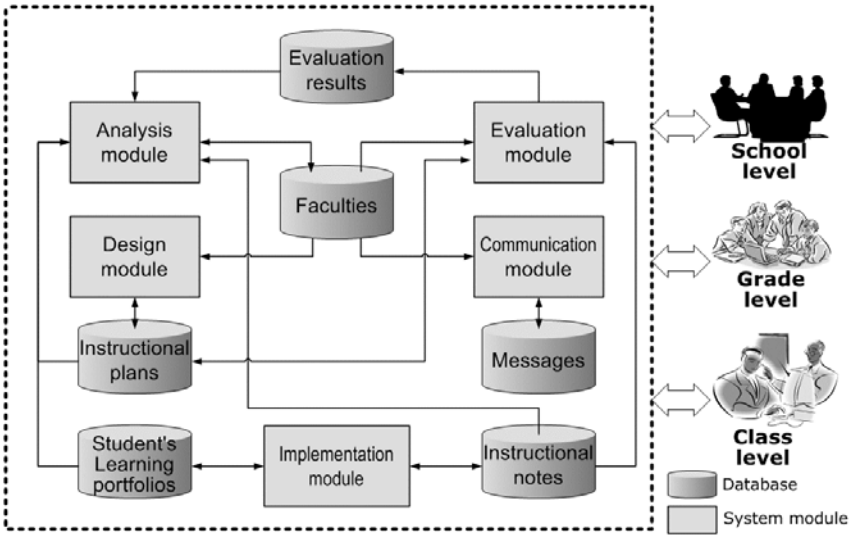

Fig. 1. System structure of ***SBCDSS***

4.1. Analysis module

The analysis module mainly provides a query & statistics tool, searching tool and checklist for all levels' participants in the SBCD. The query & statistics tool helps users conduct statistical analysis on specific information from developed and implemented instructional plans and from students' learning portfolios in the database. For example, the usage of each competence indicator, distributed percentage of each learning domain, and number of teaching hours can be analyzed (see Fig. 2). The students' learning outcomes can also be evaluated using the of the assessment statistics obtained in the e-learning subsystem. This analysis helps developers understand the previous curriculum and determine the most appropriate curriculum design.

A searching tool is used to help users query and analyze how past curriculum designers assess curriculum framework, instructional plan templates or the implementation of instructional plans. The search results comprise quantitative and qualitative data such as the average evaluation score of all instructional plans of a certain grade and the appraisal messages for a particular instructional plan.

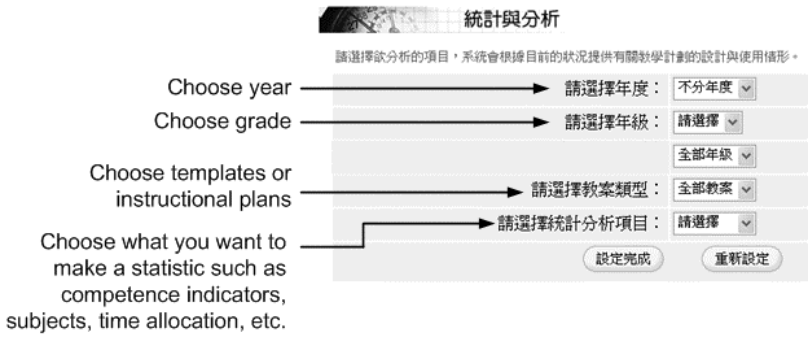

Fig. 2. Query and Statistics tool

4.2. Design module

The design module includes a collaborative design and management tool based on workflow concepts and specific criteria in different levels (see Fig. 3) to ensure the integration and continuity of the school based curriculum. The operation method employs template-based step-by-step and collaborative mechanism where users simply follow some well-arranged operational steps with suitable hints, enabling them to cooperate with other members to complete the design tasks. The overall curriculum is divided into three parts, the curriculum framework, instructional plan template and instructional plan. The content of each part is connected with that of other parts, and is completed by users in the appropriate level.

In the school level, this module mainly helps the SBCD school committee design a curriculum framework. The curriculum framework is the entire school's curriculum plan, including the topics of every subject for each grade, the overall curriculum objectives, and the distribution of curriculum implementation schedule.

For the grade level, this module can mainly help grade level representatives and subject representatives (the members of the SBCD grade committee) to design an instructional plan template. This instructional plan template is a simple instructional plan of the curriculum framework made by the school level members, which includes the instructional objectives, course framework, learning domain involved and setting of competence indicators. For example, an instructional plan template titled in "Life of the frog" comprises the content showed as Table 2.

Table 2. An example of an instructional plan template designed by grade level

Title	Life of the frog
Grade	4
Semester	2nd semester
Involved learning area(s)	Language Arts, Science and Technology, Arts and Humanities, and Environmental Education
Period(s) of class time	14-16
Introduction	A frog is an amphibiotic animal and has particularly different variation of life cycle which may interest children to explore it. In this instructional plan, we attempt to introduce the environment in which the frog lives, the differences between frogs and toads, the frog's viscera organization, and the frog's evolvement.....
Main goal(s)	Let learners: become aware of how a frog forages foods, what kind of food it eats, and the behaviors and the life-cycle of the frog, be able to differentiate frogs from toads, learn how to observe the frogs and take down the observation results, and be concerned with the importance of environmental consciousness after exploring the frog's life crisis. ……

In the class level, this module helps individual teachers or teaching groups design integrated instructional plans. The integrated instructional plan is mainly a theme combined with all teaching activities. Each integrated theme instructional plan may include several subjects, while the instruction time involved may have more than 10 periods of class time. With the assistance of the design module, class teachers can deliberately design a suitable integrated instructional plan for the class level by importing the instructional plan template. When the teachers design the instructional plan, the design module helps them design plans to collect and link up the appropriate digital materials or learning resources with the plan. The example of an instructional plan titled "Life of the frog" showed as Table 3.

Table 3. An example of integrated instrutional plan designed by class level

Title	Life of the frog <the same as Table 2>
Grade	<the same as showed in Table 2>
Semester	<the same as showed in Table 2>
Involved learning area(s)	<the same as showed in Table 2>
Period(s) of class time	<the same as showed in Table 2>
Introduction	<the same as T showed in able 2>
Main goal(s)	<the same as showed in Table 2>
<The above content is imported from the instructional plan template showed in Table 2>	
Activity 1	Frog observation
Introduction to Activity 1	In this activity, the teacher leads students to observe frogs around a pond or the frog's haunt. S/he gives a brief introduction of frogs' appearance, the place they can be found, the observation tips, and safe regulations. Then students are divided into some small groups and each group is given a work sheet for observation. The purposes are to let students understand the environment in which the frog lives, what other animals or insects also live with frogs, and the appearance of frogs. Bedsides, the ability to discussing with other peers will be cultivated as well.
Banchmark for this activity (extracted)	Science and Technology: Students aware that everything has its own recognizable characteristics and attributes. Studetns know how to use sensory organs or ready-made instrument to compare quantitative data. Arts and Humanities: 1. Students can appreciate the beauty of nature substainse, artificial substainse and artistic production.
Instructional steps	Step 1: Lecturing for introduction of flogs Step 2: Outdoor exploration and drawing the appearance of found frog(s). Step 3: Group discussion about the observation results Step 4: Group report, and

	Step 5: Collective conclusion
Instructional materials	Slides briefing for introduction of the frog [MS PowerPoint file] Work sheet for observation of the frog [MSWord file] Sounds of various kinds of frogs [Wave file]
Evaluation	Online quiz [link to an online quiz system]
Reference(s)	Web site: Dr. Yang's Frog School (http://www.froghome.com.tw/) Book: Yi-Ru Yang (2003), *Frog illustration*, Taipie, Species Publishing Co.

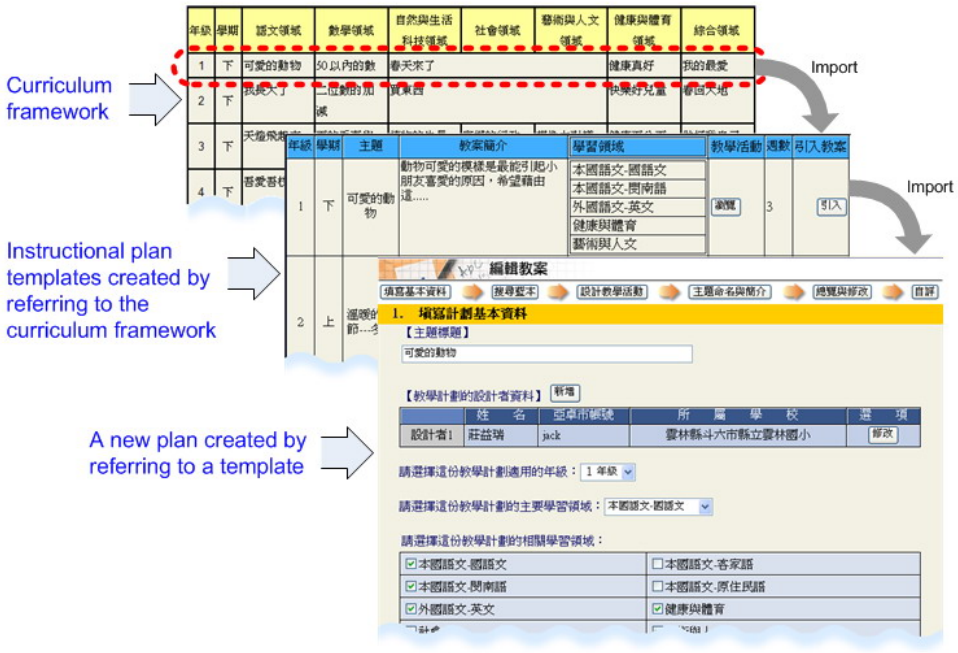

Fig. 3. Collaborative design mechanism for three levels

Figure 3 shows the collaborative design mechanism in use. The upper part of the figure shows the curriculum framework table for the school level. The middle part shows the grade level members using the framework to build a new instructional plan template. The lower part is created by class level

members who use the instructional plan template to build a new instructional plan. This mechanism allows the SBCD to be considered the requirements of each level consistently.

4.3. Implementation module

This module was designed mainly for class level implementation and offers the following tools:

1. *Materials browser*: The teacher can show specific materials when teaching by clicking on the hyperlink to launch the corresponding software based on the teaching procedure designed in the instructional plans.
2. *Instructional note*: Each instructional plan has its own instructional notepad, which is a tool to help teachers record their thoughts or reflections about the design of instructional plans and their teaching. The note is helpful to those who are interested in the plan to understand the design consideration and the points for attention while teaching.
3. *Virtual classroom*: A virtual classroom offers students a website which is accessible after class. The teachers can import the digital materials and learning resources onto the website from instructional plans. The students can use this website to read the digital materials, upload homework and run the learning project. Students can discuss their schoolwork with other students on the discussion boards, (see Fig. 4). The teachers can collect the students' learning portfolios and use them to improve the curriculum.

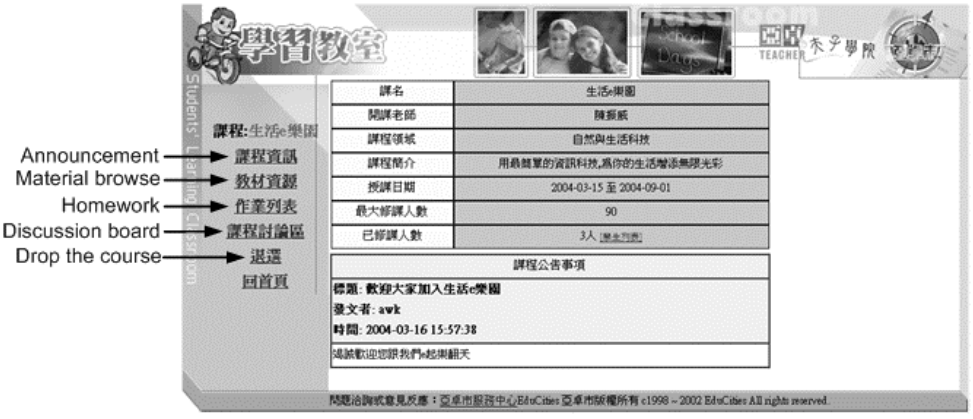

Fig. 4. e-Learning system (student interface)

4.4. Evaluation module

Each level has its own curriculum evaluation focus. The class level focuses on implementing the curriculum and curriculum adaptability; the grade level focuses on curriculum integration and adaptability, and the school level focuses on curriculum continuity, sequence and adaptability. This module offers a query tool, a statistics tool like the statistics tool in the analysis module, and a rubrics tool, which enables each level to meet its evaluation objectives. These tools are described in detail below.

1. *Query and statistics tool*: This tool enables the user to perform queries and statistical analyses based on the year, grade and type of instructional plan to obtain quantitative information of the curriculum design. For example, the school level members can choose to view the first grade Language Art curriculum during 2003 and its competence indicators usage. Figure 5 shows the system results of such a query. The curriculum development members in the grade level can query the subject involvement proportion, and then set the teaching objective distribution and the theme integration framework graph for a certain grade level or semester from all instructional plans. Curriculum integration can thus be observed and determined. Users in the class level can query in which semester a class used a particular instructional plan, what skills the students learned and how the student grades were evaluated to determine the knowledge and background skills of the students. This information can serve as reference for future curriculum design. Moreover, this tool can also be used to classify and statistically analyze the rubrics table which is described in the next items.

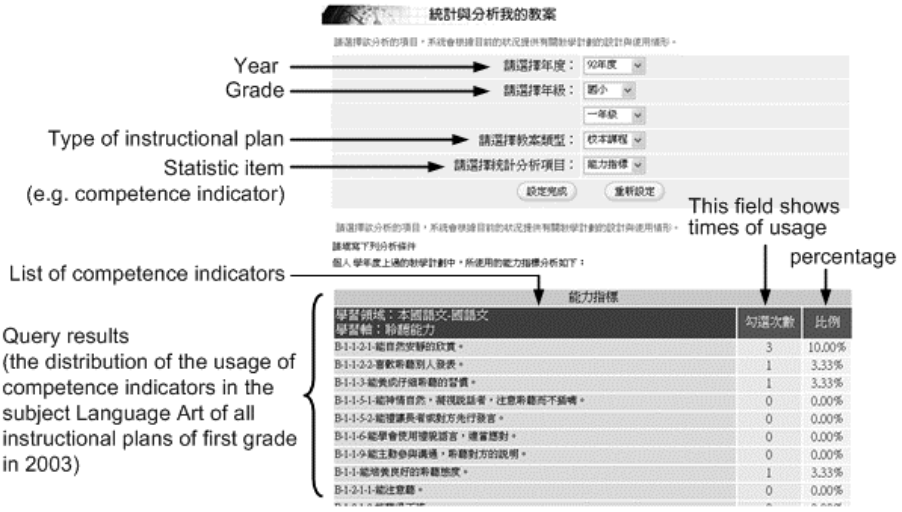

Fig. 5. Query and statistics tool querying statistics of competence indicators

2. *Rubrics table*: This module offers different curriculum development rubrics tables for based on the different rubrics requirements of the three levels. The designer can thus audit (self-evaluate) developed curriculum framework, instructional plan templates and instructional plans. Teachers who are not designers can use the rubrics table for evaluation (peer evaluation). Each rubrics table has many declarative sentences representing an evaluation framework. The designer can determine whether the product design meets the evaluation benchmark score (1-5 points). For instance, the rubrics table of the class level is composed of ten evaluation benchmarks as shown in Fig. 6.

項目	評　分　內　容	5	4	3	2	1
1	教學活動內容是否能達到學習目標	○	◉	○	○	○
	1. The teaching activities meet the learning objective.					
2	教學計劃的順序是否由易而難循序漸進	○	◉	○	○	○
	2. The sequence of the instructional plan can/cannot be easily followed.					
3	教學活動是否能引起學習者興趣	◉	○	○	○	○
	3. The teaching activities get the interest of the learners.					
4	教學活動的設計是否多樣	○	○	◉	○	○
	4. The teaching activities are diverse.					
5	教學活動的設計是否能激發學習者主動思考的能力	○	○	◉	○	○
	5. The design of the teaching activities stimulates analytical thinking.					
6	教學活動難易度是否適合大部分學習者的程度	○	◉	○	○	○
	6. The difficulty of the teaching activities is right for the level of most of the learners.					
7	學習單的內容是否與教學活動密切配合	○	◉	○	○	○
	7. The design of learning worksheet closely matches the teaching activities.					
8	教學活動是否能在預定的節數內完成	○	◉	○	○	○
	8. The teaching activities can be finished within the projected time.					
9	評量活動的設計是否能有效評定學習成果	○	○	◉	○	○
	9. The design of the evaluation activities effectively evaluates the learning results.					
10	教學相關資源的取得是否容易	◉	○	○	○	○
	10. The instructional resources are easily obtained.					

Fig. 6. Rubric table for class level

4.5. Communication module

The school level requires the pre-determined curriculum framework to be elaborate and disseminated to all faculty members, giving the curriculum development a common aim and basis. The grade level requires the designed instructional plan template to be communicated and explained to the teachers of that grade level, or shared with those from other levels, informing the teachers of the main contents of the instructional plan. This approach also prevents misunderstandings of each level's design concepts. The teachers for the class level need to share their experience in actual implementation of the instructional plan to other teachers; moreover, they can offer improvement suggestions to the grade level or school level curriculum design. Thus, the communication module has the same functions in all three levels. The main feature of the communication module is the series of diversified asynchronous discussion boards, where a board can be set up for each subject and grade (see Fig. 7). The boards allow teachers, who have the same interests, to discuss problems involved in instructional design cases, explore the knowledge domain and share teaching methods. Additionally, special discussion boards can be established for each instructional plan, allowing instructional plan authors and users to discuss plans and learn from each other.

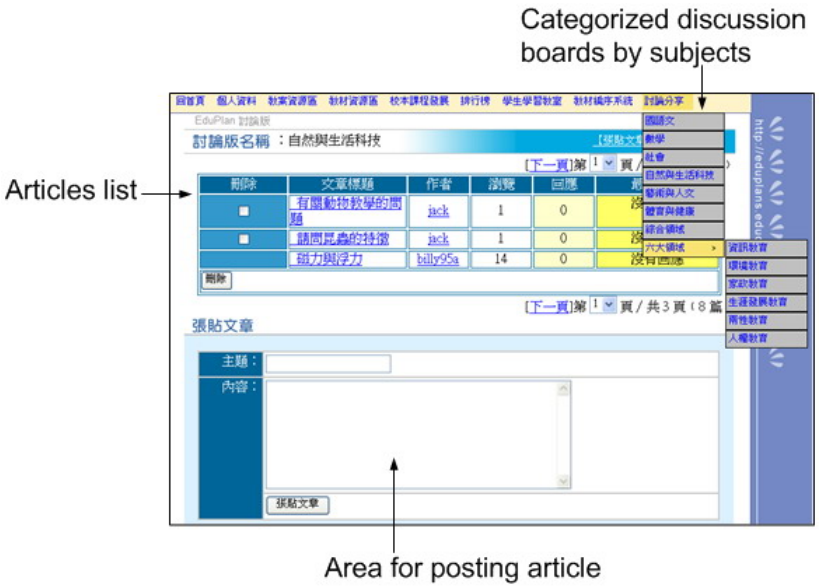

Fig. 7. Categorized discussion boards by subjects

5. System evaluation

The system was implemented in a primary school in Taiwan for one year (2003/6-2004/7). The school consists of 58 classes (each grade having 8 to 11 classes), 110 teachers and more than 1900 students. The data collection method, such as product statistics, questionnaire, and interviews are used to answer two questions:

1. Can the system improve the effectiveness of the SBCD?
2. Does each system module and tool help in the SBCD?

The research procedure is divided into three stages:

1. *Preparation* (2003/8-2003/11). The main tasks in this stage are: (1) holding workshops to familiarize participants with the system; (2) holding many small group discussions for each level to guide the teachers to think of how the system can be used for the SBCD, and (3) gathering suggestions regarding the system for system developers.
2. *Implementation* (2003/12-2004/6). The actors from different levels use the system to develop the curriculum.
3. *Data collection and analysis* (2003/12-2004/7). Observations and interviews are first conducted to gather and analyze the practicability and efficiency when the participants use the system. Second, products are gathered and analyzed. After the experiment, the research group applies a questionnaire survey (Likert-type five point scale) to gather and analyze evaluations of the system from the participants. Finally, six representative teachers from the three levels are chosen for a focus group discussion.

5.1. Overall production

The SBCD participants used the proposed system to design one school curriculum framework, 34 instructional templates and 178 instructional plans in total. One instructional plan (or instructional template) involved around 3 – 5 designers (average 4.2 designers) and 6 – 13 class sessions (average 8.8 class sessions). Although no quantitative data on the instructional plans produced is available for the case study schools on the previous semester, the interview results offer some proof as following description. The focus group interviews demonstrate that the SBCD school committee members believe that the overall school curriculum production supported by ***SBCDSS***, for the semester improved significantly. Moreover, more teachers were involved in curriculum development than in the previous semester. The reasons given by

the participants were: (1) the system offers the right level of support and lowers the curriculum development load; (2) the system provides evaluation and template mechanisms, making instructional plans easy for the teachers to design carefully, and (3) the system shows the number of instructional plans developed each year by teachers, encouraging the teachers to enhance productivity.

5.2. Monthly production of the different levels

The monthly production for each grade level and class level during the implementation process (2003/12–2004/6) is shown in Fig. 8.

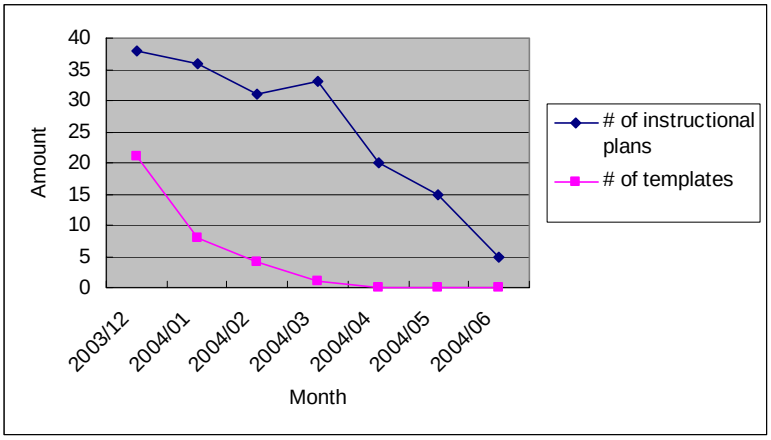

Fig. 8. Outputs of instructional plan templates and instructional plans

The production for grade level and class level reached its peak at the beginning of the experiment, as shown in Fig. 8. The number of instructional plan templates produced in Dec. 2003 was 21 (61.8%). However, 74 (41.6%) instructional plans were produced for the class level from Dec. 2003 to Jan. 2004. The reason for this mass is that the teachers normally develop curriculum before the semester starts. Moreover, Fig. 8 also shows that no further instructional plan templates were produced after Apr. 2004, while production of instructional plans was continued until the end of June. Because the instructional plan templates are references for class level in designing instructional plans, these templates must be finished earlier than the detailed instructional plans. This procedure is consistent with the

implementation procedure of creating a curriculum framework followed by an instructional template, then designing the instructional plan for each process, when the system is used to develop the curriculum.

5.3. Evaluation regarding the support system

The participant evaluations in different levels regarding the system modules on the assistance for the various tasks during curriculum development are discussed in this section. The interview material is arranged as the Appendix to explain the data. On average, more than 70% of the participants agree or strongly agree the proposed system ***SBCDSS*** can help developers on the individual tasks. When asked how the system supports the SBCD overall, the participants from different levels stated that the system meets the various needs of the different levels, enables continuity of curriculum development between each level and systematizes the entire process. Hence, teachers can easily and effectively develop school-based curriculum.

The class level participants were found to be the most appreciative of the support given the system for each task (72.7% of the participants agree or strongly agree; the weighted average is 4 out of a maximum 5), followed by the grade level (72.3% of the participants either agree or strongly agree; the weighted average was 3.8), then the school level (65.8% of the participants agree or strongly agree; the weighted average was 3.8). This distribution corresponds exactly to the load and complexity of the tasks in each level from large to small that is, class, grade and school level. Hence, the participants with the highest demands on the system are the most satisfied.

Concerning the overall view of the system modules, the following items collect the views of each level regarding each system module.

1. *Analysis module*: Even if more than half of the participants approve of the module functions (57.9% for the school level, 57.1% for both grade and class levels), the degree of appreciation is clearly lower than that of other modules. Concerning this result, the teachers who were part of the focus group interview thought that because the school did not develop enough curriculum or instructional plans beforehand, the system thus could not perform a full statistical analysis. During the semester, 55 published instructional plans and 34 instructional templates were already collected. The existing functions can be used when the system module is used again in the following semester. Furthermore, some participants believed that existing analytical functions over-emphasize quantitative data statistical

analysis and initial qualitative data classification, while neglecting qualitative data. Participants think that this part can be improved.

2. *Design module*: Participants in each level approved of the design module functions, starting from the class level (92.2%), grade level (85.7%), and the school level (73.7%). The interview data reveal that participants in the three levels believed that the design module can help teachers efficiently perform mundane tasks, and that the entire design process can make the school-based curriculum development more systematic, continuous and integrated. Additionally, participants in the grade level and class levels felt that the module can help teachers: (1) quickly query and choose instructional plans or materials for reference; (2) effectively manage instructional plans (or instructional templates) and related materials, and (3) systematically design instructional plans (or instructional plan templates). Nevertheless, some grade-level teachers stated that the design module functions are excessive and complicated. This feature can be improved in the future.
3. *Implementation module*: The used by the class level were less popular than the others. The interviewees think that the module functions are good and well-made but limited by current hardware, teaching methods and teaching load, leading to low usability. One respondent explained, "Right now, not all class levels have a projector, and using it to project the lecture is very inconvenient." Another respondent said, "The virtual classroom may be popular in the future but right now at the class level, there are still many families without a computer or cannot go on the Internet. If the teacher uses these functions, then this may lead to a digital divide."
4. *Evaluation module*: The functions of this module had 77.9% approval from the Class level, 71.4% from the grade level, and 68.4% from school level. Most interviewees felt that the module can help teachers: (1) effectively evaluate the curriculum development, and determine whether it conforms with expected competence indicators; (2) record reflections on teaching, and (3) effectively evaluate the adaptability of the developed curriculum. Nevertheless, opinions vary on how use the rubrics table in the evaluation module (self-assessment or peer assessment). The school-level participants tend to be objective, and therefore can generally apply both the self-assessment and peer assessment methods. The grade level and the class level, by contrast, tend to choose only self-evaluation, since peer evaluation can lead to untoward misunderstandings and raise psychological burden. Moreover, if the evaluator does not know well the actual teaching method and ideas of the individual being evaluated, then the evaluation is superficial. Finally, the views on the analytical module were unanimous. Most participants thought that the existing evaluation functions over-

emphasize quantitative data statistical analysis and initial classification of qualitative data, while neglecting analysis and classification of qualitative data.

5. *Communication module*: The approval rates of each level regarding the communication module functions were: class level (74.0%), grade level (75.0%) and school level (63.2%). Most of the interviewees believed that the module can help disseminate important information in each level. Nevertheless, some participants think that when using the module, the tool offered by the module must not be allowed to replace face-to-face communication. A school level participant noted, "Discussion of important matters is best done in a meeting. If there are decisions, then this communication module can help disseminate information."

In summary, the participants approved of the functions of the various modules. Nevertheless, the following issues still have to be examined and enhanced:

1. The analysis and evaluation module should be able to further analyze and categorize the qualitative data provided by the teachers.
2. The design module functions and method should not place undue burdens on teachers.
3. The evaluation module application should be objective and in-depth.
4. The usability of the implementation module in current teaching situations should be improved.

6. Conclusion and future work

School-based curriculum development is a complex and knowledge-intensive task. The participants have different backgrounds and work in different levels (school, grade and class) resulting in varying concerns of curriculum development. Based on this requirement, this study develops a web-based EPSS, ***SBCDSS***, for every phase in curriculum development (including the four stages of analysis, design, implementation, and evaluation) to offer a suitable module and tool. The proposed system is the only EPSS dedicated to school based curriculum development. Evaluation results demonstrate that the users mainly approve of each module and tool, while the whole system can improve the proportion of teachers participating in curriculum development and help curriculum development production. The system evaluation process has revealed many features which still have to be improved or built, to allow

the system to provide just-in-time help or resources and be appropriate, effective and automatic, thus fully meeting user needs.

The questionnaire results and interviews also imply that the teacher's attitude and professional knowledge are vital to the success of SBCD. Curriculum development may play as a bridge between teacher professional development and school organizational learning. The issue of how to provide an integrated information system to support the performance among the three tasks is worthy to explore in the future. In the technology aspect, rather than the ability to play as an active and constructive supporter of curriculum evelopment, the real value of technology lies in the humanistic respect. Therefore, any kinds of information technology can be applied to improve curriculum development performance under this concept, such as intelligent agent, semantic web and knowledge management system. Especially, the modern mobile technology can be combined with the curriculum development support system to construct a ubiquitous learning and instruction environment.

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Appendix. Questionnaire results of system evaluation

Questions	Strongly disagree (1 point)	Disagree (2 points)	No comment (3 points)	Agree (4 points)	Strongly agree (5 points)	Weighted average
School level(n=19)						
Analytical system can effectively help curriculum development committee to understand the situation of the entire school's curriculum development in the previous year and the currently available human resources.	1 (5. 3%)	2 (10. 5%)	5 (26. 3%)	7 (36. 8)	4 (21. 1%)	3. 6
The design system can effectively help the curriculum development committee to build the curriculum framework for the whole school	0 (0. 0%)	0 (0. 0%)	5 (26. 3%)	9 (47. 4%)	5 (26. 3%)	4. 0

The evaluation system can effectively help the curriculum development committee understand and evaluate the implementation of the school based curriculum for the present year	0 (0. 0%)	1 (5. 3%)	5 (26. 3%)	10 (52. 6%)	3 (15. 8%)	3. 8
The communication system can effectively help the curriculum development committee to discuss and communicate	0 (0. 0%)	1 (5. 3%)	6 (31. 6%)	8 (42. 1%)	4 (21. 1%)	3. 8
Average						3. 8
Year level (n=28)						
The analytical system can effectively help the grade representative and the subject representative understand the previous school year's curriculum development for each subject	0 (0. 0%)	4 (14. 3%)	8 (28. 6%)	11 (39. 3%)	5 (17. 9%)	3. 6
The design system can effectively help the grade representative and the subject representative build the instructional template for each subject during the school year	0 (0. 0%)	1 (3. 6%)	3 (10. 7%)	16 (57. 1%)	8 (28. 6%)	4. 1
The evaluation system can effectively help the grade representative and the subject representative understand the grade level curriculum implementation for the current year.	0 (0. 0%)	3 (10. 7%)	5 (17. 9%)	15 (53. 6%)	5 (17. 9%)	3. 8
The communication system can effectively help the grade representative and the subject representative communicate and discuss	0 (0. 0%)	2 (7. 1%)	5 (17. 9%)	17 (60. 7%)	4 (14. 3%)	3. 8
Average						3. 8

Class level (n=77)						
The analytical system can effectively help each class teacher know the subjects that each student has taken	0 (0. 0%)	7 (9. 1%)	25 (32. 5%)	34 (44. 2%)	10 (13. 0%)	3. 6
The design system can effectively help the class teacher in making an instructional plan	0 (0. 0%)	0 (0. 0%)	5 (6. 5%)	42 (54. 5%)	29 (37. 7%)	4. 3
The implementation system can effectively help each class teacher implement the instructional plan	0 (0. 0%)	4 (5. 2. %)	24 (31. 2%)	38 (49. 4%)	10 (13. 0%)	3. 7
The evaluation system can effectively help each class teacher reflect and modify the instructional plan	0 (0. 0%)	2 (2. 6%)	14 (18. 2%)	45 (58. 4%)	15 (19. 5%)	4. 0
The communication system can effectively help each class teacher communicate and discuss with their co-workers	0 (0. 0%)	4 (5. 2%)	15 (19. 5%)	40 (51. 9%)	17 (22. 1%)	3. 9
Average						4. 0
Total Average						3. 9