Lesson Page Structure and Customization in WME

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Abstract

Lanzhou University is cooperating with Kent State University on the Web-based Mathematics Education (WME) project. Per teacher and per class control, editing, and customization are important advantages of the WME system. The basic Topic Module (TM), Topic Lesson Page (TLP), and Visibility-Control Section (Vsec) already go a long way to achieve these advantages. By further organizing each TLP into editable units, we can better support customization and finer grain interoperability, making it easier for developers and end users. Textual Unit, Program Unit, Image Unit, and Question Unit are defined and their editing support implemented. A Web-based authoring and editing tool TLP Wizard can help teachers edit/create TLPs quickly and easily.

1. Introduction

WME is a modern distributed system on the Web for mathematics education. The WME system conforms to open standards, works with regular browsers, delivers integrated and complete lessons, enables easy customization, provides systematic access to client-side and server-side support, and allows these independently developed components to interoperate seamlessly. In short, WME seeks to create a Web for Mathematics Education.

Previous work done in the WME lesson component structure (Topic Modules, Topic Lesson Pages, and View Sections) and how they aid methods for handling customization and interoperation are reported in [3] and [4]. For instance, different teachers emphasize on different topics, which may also vary on a per-class basis, so it is likely that a teacher would personalize or customize lesson pages, but it is unlikely that a teacher be familiar with the complexities of programming. Flexibility is one of the advantages of the Web-based Mathematics Education (WME) system. That is, freedom for teachers to customize lesson plans and lesson material. The customized components can then be shared and distributed to anyone else using WME. Offering such flexibility demands self-sufficiency among WME site components.

When a WME model site is deployed in a new school, the webmaster performs installation and configuration (including localization). This initial configuration includes setting the school name, logo, page styles, defining a list of teachers, classes, names of students in classes, etc. The

teachers then perform their own customizations for each class that they teach:

- Select Topic Modules to use
- Select Topic Lesson Pages to use within Topic Modules
- Review and edit each Topic Lesson Pages when necessary
- Pose questions and review students' response

A principal advantage, as compared to other online mathematics education materials, is that WME offers lessons that are complete and classroom-ready. The lessons are created by the WME Research Group at Kent State University, who works in close relations to Mathematics Education in the College of Education and mathematics teachers in regional schools [5]. With WME, teachers have an easy and effective way to deliver ready-made lessons in a tailored form to their classes.

In February 2005, a pilot WME site was deployed to Lanzhou University, China. Initially, our task was to translate the WME site from English to Chinese in order to open up a new spectrum of audience in the Chinese community. During the translation, we found that a WME Web page includes not only text but also Web programming, so it was necessary to discriminate between programming and educational content before the translation. We quickly learned that this was not an easy task. Ones who complete the work of discriminating must possess skills in both of Web programming and foreign language translation. Because WME is Web-based and therefore worldly distributed, it will likely be used and applied in many countries, under many languages. Therefore, support for simple translation must be provided within the system. To do this, we must refine the structure of a Topic Lesson Page (TLP) to contain unique units for content, programming code, and others. This newly refined structure will also have other implications aside from the ease of foreign language translation.

2. The TLP Architecture

According to [3], TLPs are lesson pages that convey some mathematical concept. Like Topic Modules, TLPs are themselves product of arrangement of even smaller entities, known as View Sections or VSecs. We now address the question: through localization and customization, how can WME provide different content to different students on the same topic lesson in the same WME page? The TLP architecture will be considered further.

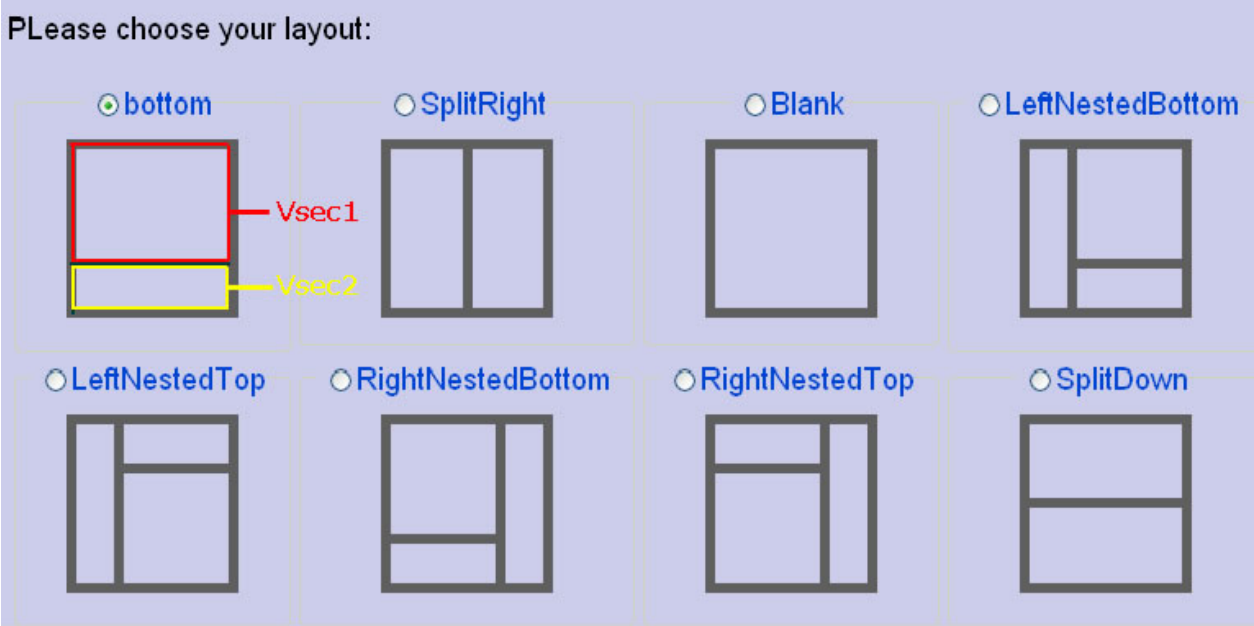

Fig.1 Customize the frame of TLP using VSec

A TLP may have different page layouts. Fig.1 shows commonly used page layouts for Web pages. The layout only relates to the visual presentation of the lesson page. Within each TLP, a teacher, at the time of lesson delivery, can control the visibility of each VSec by students. This control allows teachers to hide parts of the page to avoid distraction and to focus student attention on the part being discussed.

Analysis of the TLP structure suggests that organizing a lesson page into discrete editable units can enhance customization and interoperability. A VSec may contain one or more such editable units.

We define four types of units: Program Unit, Text Unit, Image Unit, and Question Unit (we abbreviate these PU, TU, IU, and QU respectively throughout the paper). Each unit is an independent component in a TLP. Their meanings are as follows:

- PU (Program Unit): Mainly refers the programmable content in TLP pages, including SVG, JavaScript, Applet procedures, and other Web procedures.
- TU (Text Unit): Refers the text content in the TLP, including the format of the text and hyperlinks. In fact, each TU is a snippet of a complete XHTML document.
- IU (Image Unit): Refers the graphics and animations in the TLP and their setting information, such as width, border, margin etc., not including SVG (SVG is considered as a PU).

- QU (Question Unit): Refers the sets of assessment questions in the TLP.

Below, Fig. 2 shows the refined architecture of a TLP.

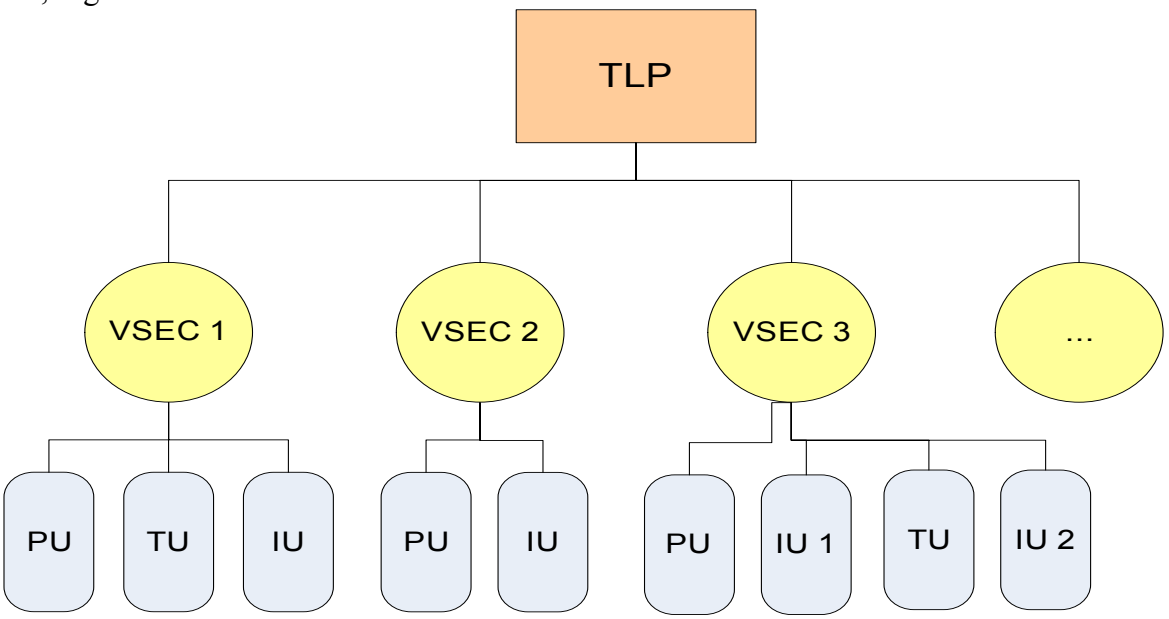

Fig. 2: The Architecture of a TLP

According to [3], a TLP is in fact a skeleton that dynamically includes files each of which represents a VSec. With unit-based TLPs, each VSec can now include multiple files each representing an editable unit. Still abiding by rules of customizability, everything down to the individual units is editable by the teacher. The following sections describe the editing and customization of the unit-based TLP structure.

3. Customizing a Unit-based TLP

In WME, a TLP unit is a content organization basic component. Teachers can design a TLP through selection, arrangement, and combination of the unit. After taking these steps, the WME system will generate the TLP automatically. No further work is needed from the teacher for producing a TLP, whereas current Web technology requires teachers to be familiar with at least XHTML. The TLP building process is akin to using building blocks to produce a desired structure, where a TLP unit is a single block. The teacher interface for TLP production is called TLP_Wizard. It is an editing tool which processes organization and designation through fundamental units. Its main functions are as follows:

- Edit the basic information of TLP, such as name, category, introduction, and so on.
- Customize the TLP page structure.

- Display or hide VSecs to students at any given time for focus.
- Add or delete units in each VSec at will.
- Move units from one VSec to another.
- Change the position of a unit in VSecs.
- Edit Image Unit by replacing the picture or animation, changing the size of the picture and animation, and editing the annotation of the picture and animation.
- Merge and split Text Units.

Fig. 3 shows the TLP_Wizard editor in the state of selection units to a TLP. The following illustrates the main steps to manufacturing a TLP by using the TLP_Wizard.

- Step 1: Establish the basic information of TLP, including TLP name, category, lesson text, and so on.
- Step 2: Select the information structure of the TLP (for example left-narrow and right-wide structure) as shown in Fig 1.
- Step 3: Choose units from a unit databases in each VSec, and decide the positioning of each unit.
- Step 4: Preview, save, and publish the TLP

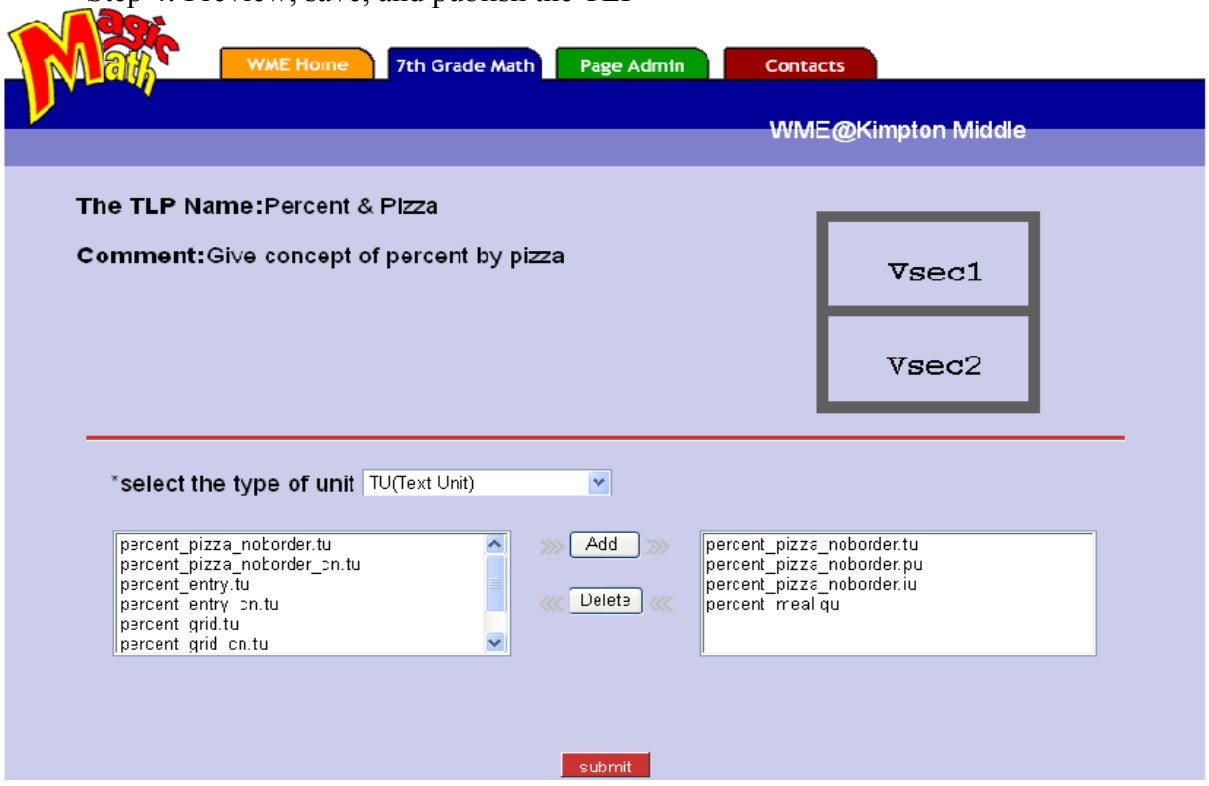

Fig.3 selection units from database to a TLP

There are two methods to realizing the final TLP page from end-user perspective:

1. *Synchronous TLP Publishing:*

Each time the teacher finishes editing the lesson content, s/he must publish the lesson. All TLP components, such as Web procedures, SVG files, text, etc. will be integrated to an independent

file in the *Publish* phase. The WME system will transmit this generated file when end-users access this TLP. The advantage of this method is that is lessens the server load. Every page visit is just a simple page transfer. The shortcoming is that each time that the teacher edits a page, s/he must run through the publishing process. This increases the teacher's work and the manufacture time.

2. Asynchronous TLP Publishing:

Server generates the TLP on-the-fly. This method does not need a publish phase. Each time a student or teacher visit the TLP, the TLP page will be generated a temporarily TLP file according the TLP inside organization. This realization method is simple. It reduces the work of teacher, but in expense of server process, where each page visit now requires some peripheral script processing/interpretation before it can be transmitted to the end-user.

These two different publishing methods will also have other implications. Because WME is a distributed system, there are many distributed school nodes in the entire system. More than one math teacher will be able to use WME within a single school. In this case, a teacher may share TLP curriculums to other teachers in the same school or different schools. Likewise in the distributed scale, a teacher can also export their customized lessons to other sites.

In the synchronous publishing method, teachers can export published TLPs to other sites. Because these lessons don't include separated Unit file, these lessons can not be edited further. We call this method "read-only sharing", and it attempts to protect against plagiarism. On the other hand, teachers may also export all the TLP file including separated Unit file and independent TLP file. In this way, lessons become the default copies that can be further edited and customized. This method is advantageous to each teacher to improve the course content further through series of refinement. We called this “update sharing”. Finally, the last permission is "not sharing".

4. TUedit: A Tool for Editing and Customizing the Text Unit

There is an abundance of texts and materials in the mathematics curriculum. From the above we know that a TLP may include several TUs, and that, in each TU a teacher can edit its content freely. WME offers a visual Web-based text editing tool called TUedit (shown in Fig. 4). TUedit offers three modes of viewing: visual design view, code view, and browser preview. The visual design view allows teachers who are not familiar with coding to design TUs intuitively. For the ones who are familiar with XHTML can edit code using the code view. The browser preview allows teachers to preview the result of the TU after editing. In all, TUedit is akin to a lightweight version of visual Web editor giants such as Macromedia Dreamweaver and Microsoft Frontpage.

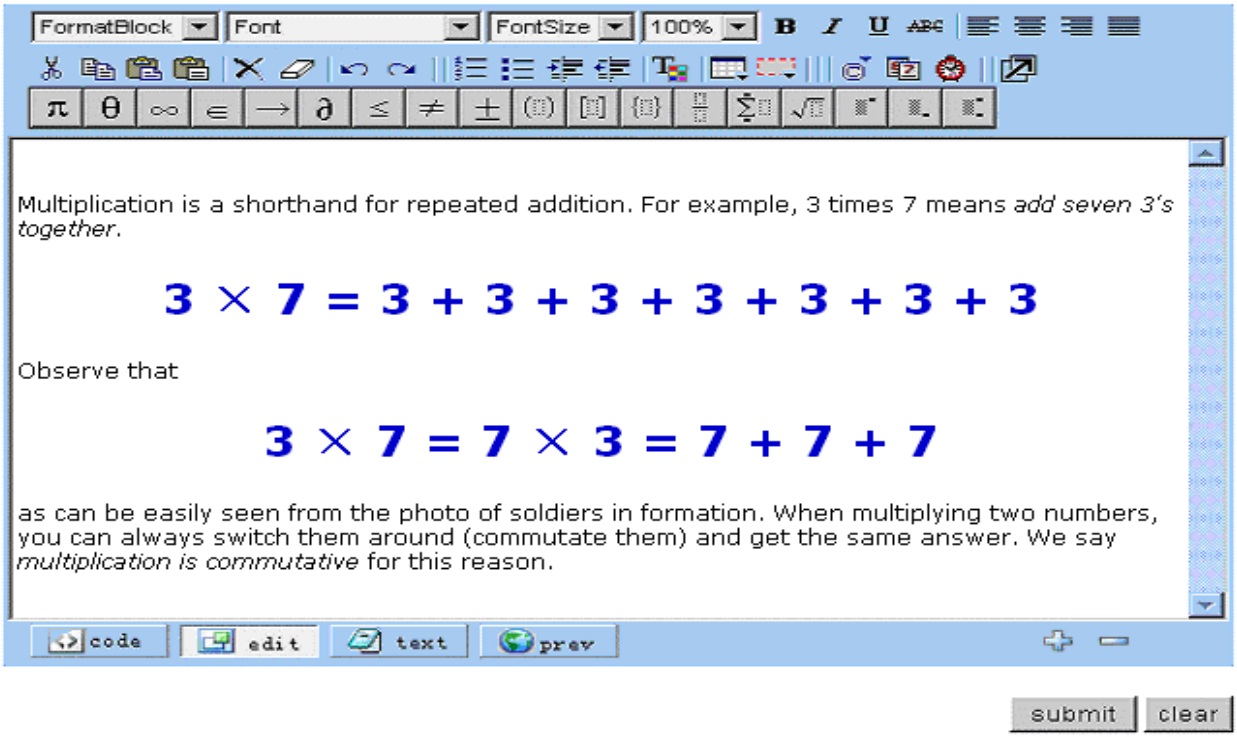

Fig. 4: A TUedit Session

The primary characteristics of the TUedit include:

1. TUedit supports Multi-languages environment. Many languages are supported in TUedit including English, Simplified Chinese, Traditional Chinese, Japanese, etc. In TUedit, teachers can select the language to edit curriculum. A language translation utility is available. In this way teacher can achieve the complete custom-made individuality texts. The separation of TUs from other units makes language translation possible.
2. Easy to operate under the WYSIWYG (what you see is what you get) environment. TUedit includes nearly all functions needed of a text editor such as copy, paste, undo, table creation, font formats, scripts, colors, etc. The system can automatically translate the content of editing text into XHTML language, so TUedit does not require Web programming knowledge from the content authors.
3. Four types of editor views make TUedit flexible: the visual design view, code view, plain-text view, and browser preview. The characteristics of these views were discussed previously save one: the plain-text view provides an environment for editing plain-text (no Web-related code involved). The text of this view has no XHTML element formatting. So the text can be directly transmitted to WME Translation Service.
4. TUedit supports MathML. WME provides mathematical formula editor, MathEdit, which allows the manual manipulation and visual generation of MathML code. It will interact

seamlessly with TUedit, and allow it to display the mathematics formula correctly on the TLP.

5. Editing and Customizing the Program Unit

A manipulative is a user-interactive element within the Web page such as a game or exercise that allows students to interact with a mathematical application (for instance, a line plotting tool). The manipulative content is in the WME curriculum core, and is written in JavaScript, SVG, Flash, or some remotely accessed CGI, etc. We call the source code of manipulatives a PU. Each PU can be deployed in multiple TLPs and even multiple times within one TLP. In a classroom, different teachers may want to individually display to the same manipulative in order to meet demands from different students. For instance, a teacher who is instructing two classes may realize that one is more advanced. This teacher can then set some more challenging parameters in the manipulative for the advanced class. Again, WME must design these PUs in such a way that it avoids assuming any programming knowledge from teachers. WME can let the teacher edit Web program easily through change the basic parameter. For example, a teacher may change a manipulative with a 3x5 grid to one with a 10x10 grid for one class and a 2x2 grid for another by simply editing these values.

When teachers teach the topic of "percentages", he can select a "dining out" TLP in WME (as shown in Fig. 5). The parameters of the PU in the TLP mainly have "food name" and "unit price". In this way the students may have a better understanding of problem and an enduring impression.

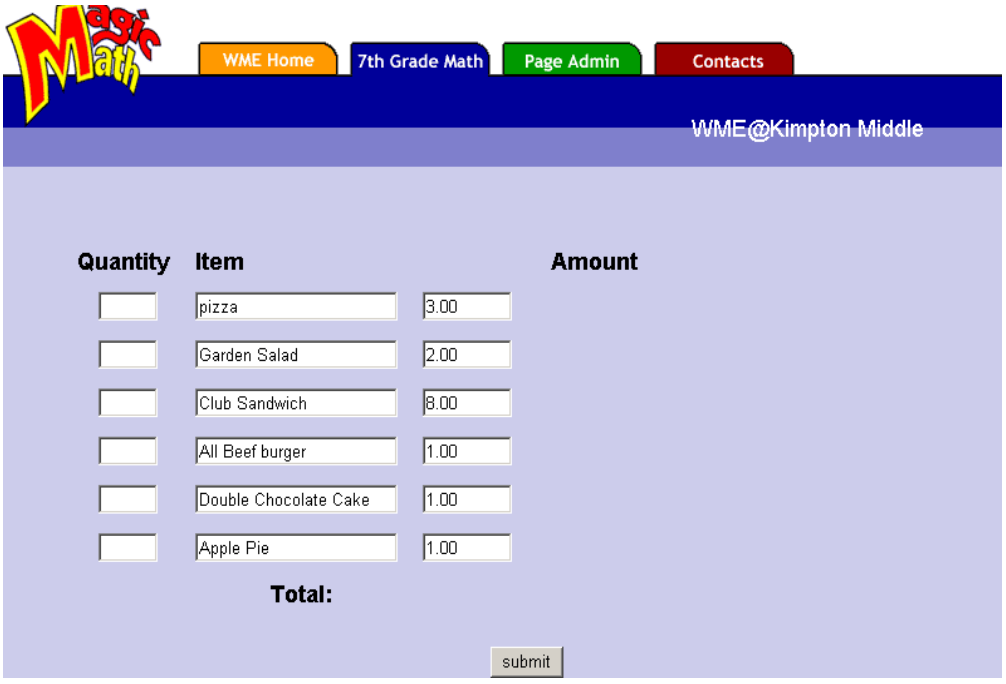

Fig.5 The Editing the PU of "Dining Out"

In WME, the realization of editing PU is mainly by the separation the Web program and its parameters. Fig. 6 Shows the how a TLP call a PU and its parameters and how to edit a PU.

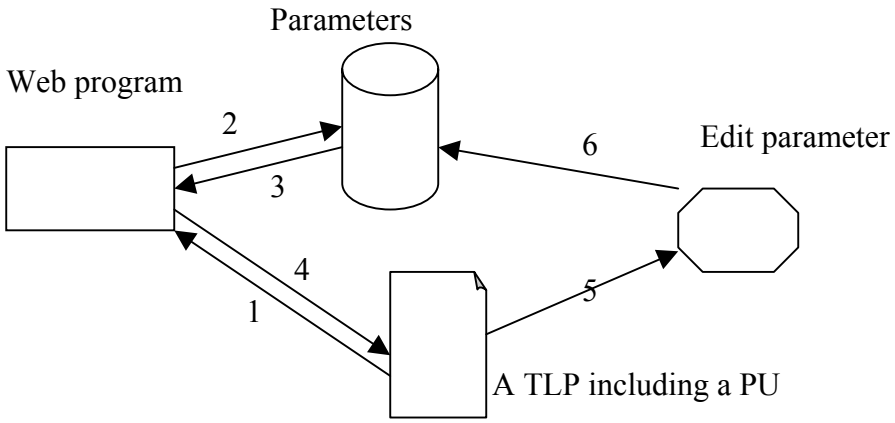

Fig. 6 editing and customizing PU

Certainly, WME also provides the advanced editing function, at the same time, permits the Web programmer and the teachers who *are* familiar with Web programming edit the code itself to realize the Web procedure.

6. Conclusion and Future Work

The WME site organization hierarchy from above to below has been further refined to: TM, TLP, VSec, and unit. The unit structure allows for finer grain levels of customization in WME. Fig.7 illustrates an overview of the customization organization of the unit-based TLP. Teachers and other experts can easily and effectively design and edit the curriculum without the skill of computer Web programming. It is an apparent difference from other mathematics education systems.

There is much work ahead in WME. In China, we will perform more research into WME together with our collaborators of Institute for Computational Mathematics (ICM/Kent, USA). These include:

- Support of editing where the teacher create or modify VSecs in terms of which units it includes
- The efficient way to keep track and store the customization on a per teacher and per class basis.
- Developing the WME curriculum content according to the mathematics teaching standard made by Chinese Ministry of Education.

- Web Translation Service (WTS) and enable multi-language support in WME. WTS is a tool within WME that can realize pretreatment of translation, machine translation, translation memory and reusing of the translation result.

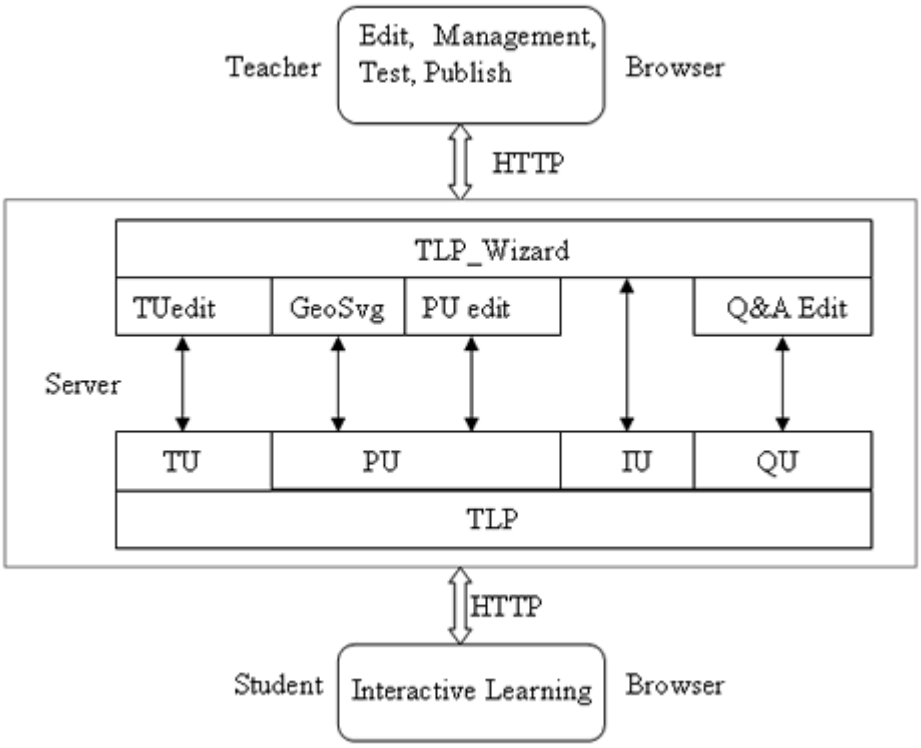

Fig. 7: Overview of the Customization of a Unit-based TLP

7. Acknowledgements

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