Practical Teaching Improvement of Hydrology Stimulation Majoring in Water Conservancy

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Abstract. According to the characteristics of the education of professional degree postgraduates and the teaching objectives of hydrologic simulation courses, the practical teaching requirements in the Cultivation of hydraulic engineering professional degree postgraduates are discussed. Based on the analysis of the current teaching problems, the reform direction of practical teaching for hydraulic engineering master's degree students is discussed from the aspects of adjusting course teaching content, increasing practical teaching content, optimizing classroom teaching method, improving assessment and evaluation.

1. Introduction

Improving the quality of graduate education has always been a top priority in the work of graduate education in universities. Cultivating high-level and high-quality graduate students is very important for China’s scientific and technological development and social progress. The hydrological simulation course is an important foundational course for graduate students majoring in water conservancy engineering[1]. The Master's degree program in water conservancy engineering at Jinan University mainly offers the course "Computational Hydrology and Hydrological Simulation" for hydrological simulation, which is one of the nine required degree courses in this major and also one of the earliest courses offered. Compared with the cultivation of academic degree graduate students, the history of professional degree graduate education is relatively short, not mature enough, and lack of effective basic course teaching mode. Domestic researching shows that the teaching of professional degree graduate students should focus on the engineering practices and professional skills development. Therefore, in response to the characteristics of professional degree graduate training, conducting improvements of teaching content and methods for hydrological simulation courses, and tailoring teaching according to individual needs, plays a crucial role in improving the quality of student training.

At present, in the graduate teaching of hydrological simulation, there are mostly few practical training contents. The main teaching method is still office coaching, with some supplemented by physical experiments of hydrological processes under limited conditions[2]. This traditional teaching method is currently difficult to meet the needs of students for understanding hydrological simulation principles and even cultivating practical modeling skills. The hydrological models at present used are more complex mathematical models that require computer simulation. At present, the teaching of this course involves fewer practical parts, which is not conducive to cultivating and improving students' practical hands-on abilities. As an important technical methodology in hydrological simulation, this course requires students to be able to skilled use some common hydrological simulation software. Therefore, how to appropriately introduce practical teaching elements, further stimulate students' interest in hydrological simulation and modeling, and improve the teaching level of graduate students is the main problem that the hydrological simulation course urgently needs to solve. To this end, by enhancing the internship process on the computer, a solid foundation is laid for future research and work[3].

The course teaching reform includes adding some advanced modeling theories contents and corresponding modelling tightly following the computer technology development. Correspondingly, to improve student’s hydrological simulation skills, experiments which require students to proficient use some professional hydrological simulation software are introduced. Through the interactive modeling experiment mode, it can stimulate students’ interest and exploration spirit, give full play to students’ learning initiative and creativity, so as to improve the teaching quality.

2. Teaching Methodology

Based on different hydrological simulation software, the practical teaching content and the feasible experiment class distribution are designed and arranged. and the teaching requirements of practical teaching are analysed and demonstrated. The selected hydrological simulation software basically needs to meet the characteristics of having a good user interaction interface, data organization and analysis ability, open source and free access of the program, and easy manual adjustment of model parameters. Students do not need to write program code by themselves,
which solves the problem of some students lacking programming ability to independently or collaboratively program and implement models. Through hydrological simulation, the simulation results can be displayed in real-time on the computer. Students can intuitively examine the impact of various control parameters on the simulation results of various hydrological elements of river runoff, thereby enabling them to have a deeper understanding of the hydrological modeling process, hydrological model principles, and the application of hydrological simulation.

Practical teaching cultivates students’ practical ability, which must be realized by students’ own practice. In order to improve the quality of experimental teaching. We divide the experimental project into three parts:

(1) Basic data processing module: mainly responsible for data organization and preparation before modeling. Before class, the data needed is sent to the students, and then students use ArcGIS software to perform rainfall spatial interpolation, DEM modeling, and other spatial data organization and analysis in class. Some content can be implemented through Python programming, requiring students to determine their own experimental plan and choose appropriate tools to implement, Teachers only provide explanations based on the completion of students;

(2) Component based hydrological model module: The main feature of this type of experiments is that the model software is applied as a plugin to GIS software such as ArcGIS. Students can assemble hydrological models based on the hydrological model construction method explained by the teacher, assemble hydrological models based on the experimental results completed in the basic data processing module, and optimize the model principle and parameter calibration process through script language.

(3) Comprehensive heuristic experimental module: Based on the actual development and utilization of water resources and non-point source control problems in some example watersheds, collect and organize watershed data, analyze hydrological model requirements, organize relevant data based on actual problems, and use the Basin platform to construct a comprehensive hydrological model. On the basis of optimized modeling, use the hydrological model constructed by oneself to solve actual problems, and conduct in-depth exploration of the significance and role of hydrological models based on experiments.

The design and arrangement of practical teaching content are shown in Table 1.

Table 1. Formatting sections, subsections and subsubsections.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Times</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Rainfall spatial interpolation operation; Construction of Digital Elevation Model</td>
<td>2 hr</td>
<td>Proficient in using ArcGIS software for rainfall spatial interpolation, DEM modeling, and other spatial data organization and analysis.</td>
</tr>
<tr>
<td>2 TOPMODEL model</td>
<td>2 hr</td>
<td>Able to use ArcGIS software for terrain index extraction. TOPMODEL modeling can be implemented using programming languages.</td>
</tr>
<tr>
<td>3 SWAT model</td>
<td>2 hr</td>
<td>Proficient in using SWAT software for modeling; Simulate hydrological processes and analyze issues such as non-point source pollution based on examples.</td>
</tr>
<tr>
<td>4 HSPF model and operation of Basins software</td>
<td>2 hr</td>
<td>Master the various functions of Basin software, be able to establish watershed rainfall runoff models and conduct model validation.</td>
</tr>
</tbody>
</table>

3. Typical Example and Discussion

Analyze the design and implementation of experimental projects using the HSPF model and Basin software application operations as typical examples.

The HSPF model is a hydrological model developed by the EPA organization in the late 1970s. The full name of HSPF is Hydraulic Simulation Program Fortran, originally written in FORTRAN language, mainly used to simulate hydrological processes. The model is developed based on the Stanford hydrological model, and after years of continuous development, many modules for simulating water quality have been added, gradually evolving into a comprehensive non-point source simulation tool for simulating watershed hydrology and water quality. In addition to being able to simulate runoff, it can also simulate processes such as river sediment and sediment, transportation of various pollutants, and river water flow. At present, models are widely used in simulating watershed hydrology and water environmental effects under changes in climate and underlying surface conditions. This model is an excellent representative of semi distributed hydrological models and is internationally recognized as one of the best simulation models for non-point source pollution in river basins. It has been widely used abroad. At present, the model is integrated in the form of WinHSPF model in the non-point source simulation platform Basins software of EPA. It can be very convenient for modelling.

This experiment mainly requires students to master the operation of the Basin software and be able to apply the software for HSPF hydrological modeling. Students are required to master the various functions of the Basin software proficiently, and be able to establish watershed rainfall runoff models and conduct model validation.

- Students install the Basins software and load relevant data into layers based on the instance data prepared by the teacher, practicing downloading and processing different types of spatial data.
- Using raster elevation data (DEM) 02060006.shp and preprocessed digital river network data sta.adf for watershed w_Branch.shp divides sub watersheds. See fig. 1.
Use the WDM Utility tool (see fig. 2) to organize the data in B4data \ Data Files \ West Branch Weather Data \ into WDM format files. Practice filling in and extending time series data, generating data, aggregating and segmenting data, and displaying and analyzing data.

Using data sets in \b4data\Data Files\Predefined Delineations\West Branch and \b4data\Data Files\data\PBackup\landuse, Launch and build WinHSPF project. Remind students of ensuring that the basin has three shapefiles: Subbasins, Streams and Outlets (shown in fig. 3).

Familiar with the model parameters. Click the GenScn icon to run the GenScn program, and use the program to calibrate the model parameters. Let the students compare the annual total runoff deviation and the
seasonal total runoff deviation to adjust the parameters of LZSN and UZSN. As shown in the fig. 4, the parameters of INFILT, KVARY and AGWRC were adjusted by comparing the seasonal flow deviation.

![Fig. 4. Model parameters calibration of WinHSPF](image)

At present, due to the relevant requirements of course teaching, the practical teaching environment of this course is mainly implemented outside of class. The teacher arranges relevant teaching content for students in the classroom and flipped classroom environment, and students choose to implement it after class. Finally, the relevant results are discussed and displayed in the classroom. From the perspective of implementation effectiveness, compared to the original classroom teaching method, student enthusiasm has been improved to a certain extent, and feedback from students in classroom teaching is also more positive, forming a positive complementarity. Students’ proficiency in applying hydrological models in subsequent research and paper writing proves the effectiveness of the teaching methodology.

4. Conclusion

The training of professional degree postgraduates should pay attention to the teaching mode of engineering practice and skill training. Hydrological simulation courses attach great importance to the cultivation of practical ability such as application modeling method and software use. Therefore, according to the characteristics of professional degree postgraduate training, it is of great significance to optimize the course structure, expand the teaching content, strengthen the effect of practical teaching, and improve the practical teaching, so as to form the teaching mode of combining theory with practice, combining course content with engineering practice, combining teaching with scientific research, and cultivating compound talents of water conservancy.

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