Design of Data-Driven Visualization Teaching System for Preschool Basketball Courses

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Abstract. Some studies have shown that basketball can promote the development of young children’s nervous system, exercise their physical coordination ability, allow young children to have a team awareness, increase young children’s social time, and establish social relationships. However, there is a problem of high system resource consumption level in the traditional visualized teaching system for infant basketball courses. Therefore, a data-driven visualized teaching system design for infant basketball courses is proposed. The hardware part adopts the intelligent display terminal DMT80480507OSW to realize human-computer interaction, which allows children to increase learning interest through human-computer interaction. The software part uses data compression algorithms to compress basketball course resource data. After testing, the feasibility of the design system was proved to provide richer teaching resources for children’s basketball courses.

Keywords: Data driven · Infant basketball · Visualization · Teaching system

1 Introduction

With the continuous development and progress of the country and society, the value and significance of preschool physical education have been increasingly affirmed and valued. Researchers have gradually realized that by paying attention to whether physical education in educational institutions provides young children with opportunities for comprehensive physical and mental development, including opportunities for physical and psychological development [1]. As the first stage of the education system, kindergartens have assumed more responsibilities. It is here that children’s lack of activities caused by the restrictions of civilization is first compensated; it is also here that children get a living space that meets their needs [2]. Sports education has been considered...
as a field of experience established from a professional perspective, and it is formally represented as “sports lessons” that are regularly conducted in kindergartens.

Ball games have a broad mass base in China, especially with the continuous improvement of people’s living standards, the development needs of national sports, and the frequent appearance of Chinese ball players in the news media in high-level competitions in the world, such as Yao Ming in basketball, Li Na and Zheng Jie in tennis, Zhang Jike and Zhang Yining in table tennis, etc. To make ball games a popular sport among educational institutions, families, communities, especially young children [3].

Studies have found that basketball has a good comprehensive effect on fitness and intelligence for young children. First, when children are exposed to basketball, they observe the direction, height, speed, distance, and size of the ball to promote the development of their perception of orientation, space, and time. Secondly, children’s brain, eyes, and limb movements coordinate and cooperate in the action of shooting, striking, and throwing. Judging the direction of the movement through the shouts of teachers and teammates can effectively promote the nervous system’s ability to control limb movements, as well as vision, hearing. The coordination and coordination of consciousness can improve the development of children’s motor skills [4]. Thirdly, the racquets and dribbling movements in basketball require the cooperation of left and right hands and feet. The coordinated movement of both sides of the limbs is conducive to improving the balanced development of left and right brain intelligence of children and laying a good foundation for the development of children’s learning and thinking skills [5] foundation. In addition, basketball requires teamwork, cooperation in relay, cooperation in offense and defense, and observance of the rules of the game, which is conducive to the benign shape of individual child socialization [6]. At the same time, in basketball, children can naturally recognize the rules of playing basketball, and use various thinking activities to win basketball games, which has promoted the intellectual development of children.

In recent years, information technology has achieved remarkable results in all walks of life and has greatly promoted the progress and development of society. In the education industry, with the popularization of multimedia teaching and application updates, the advantages of information technology in teaching have become increasingly prominent, and it has continued to move beyond the pure application model to the independent research and development model, especially in higher education. The “information-development” combined education informationization development model is constantly emerging [7]. Practice has proved that the “Internet + education” education model is leading our country to the era of educational informatization 2.0, and using education to modernize education will be the only way to achieve high-quality and balanced development of education. Data-driven technology originates from the computer field, which is mainly guided by the data in the database during programming [8]. Starting from the existing problem facts, based on a large amount of intermediate data, combined with data processing and analysis methods, effective information is obtained from a large number of raw data to achieve multiple goals of data forecasting, data evaluation, data monitoring and diagnosis [9].
Data-driven technology can be used to make up for the shortcomings of traditional education methods. Designing a data-driven visualized teaching system for children’s basketball courses can also better solve the problem of excessive system resource consumption in the traditional system.

2 Overall Framework Design of Visualized Teaching System for Infant Basketball Courses

The system architecture design uses the B/S architecture and uses ASP.Net technology to develop and design the infant basketball teaching system. Its characteristics are simple deployment and convenient maintenance. According to the project requirements and the mature design architecture on the current network, the entire system software architecture design uses the SSH framework [10]. The Web server is deployed using the IIS server, and the database is managed using the SQL database management system. The UI, business logic handler, and data access logic are all deployed by the Web server. The data access and control program uses PHP technology to achieve connection and access to the SQL Server database. The user interface uses technologies such as HTML and JAVA to design and implement the UI interface. The UI interface interaction is implemented using relevant components of ASP.Net. The data structure, business thinking logic, and view presentation under this system are relatively separate and concrete, which is more conducive to system maintainability and scalability. The overall system architecture is shown in Fig. 1.

![System architecture design](image)

The whole system architecture combines the practical application mode, which is suitable for children’s learning characteristics. At the same time, it summarizes the valuable experience of B/S architecture time development, which has high reusability. As shown in the figure, according to J2EE development standard framework, the architecture of infant basketball teaching system includes three specific layers: presentation layer, business layer and data persistence layer. In practical application, combined with the automatic code generation tool, it supports the whole system architecture, and can also generate a large number of repetitive basic codes in a short time, which can make the practical development of early childhood teaching system focus on the development and design of business logic, effectively reduce the resource consumption of some links in the system development, and improve the quality and construction efficiency of the system Rise. The system architecture is described as follows:
(1) Interface layer
The interface mainly provides an interactive display interface for preschool basketball teaching systems and preschool teacher users. It is located at the client end of the system software and initially verifies the data on the display interface. In use, a request for a child basketball teaching service is sent from a Web browser, and then received by a Web server. The request information is encapsulated by the user, processed by the Web server, and then displayed in the user’s browser in a specified manner. The interface layer provides users with a unified data request entrance, which separates page display and data content. It is an international standard mechanism in modern information technology. It can form a consistent treatment of abnormal situations, is flexible, simple and effective, and facilitates function expansion and maintenance.

(2) Business layer
The business layer transforms the outgoing data structure of the interface layer into the data of the business layer and processes it. It is responsible for the logical thinking processing of various business work. After the system runs, it first accepts the user’s request, obtains the user’s basketball teaching data from the request data, calculates and processes it according to the specific rules, interacts through the way of components and services, and finally uploads the processing results to the server, which encapsulates the processed results again and returns them to the client.

(3) Data persistence layer
The data persistence layer is a relatively independent area for data persistence. It not only manages the mapping from the Java language to the database, but also provides a way to query teaching data and data acquisition for young children, to greatly reduce the time for manual development using JDBC and SQL to process data. This layer is mainly responsible for data interaction with the underlying database system, including the logical processing of system data. Accept the web server’s request, complete the database query and modification operations via the internal interface, and transfer all processed results to the server.

The operation of the system is inseparable from the network architecture, which provides a blueprint for the design, construction and management of a communication network. In the design of the network framework, the visual teaching system of children’s basketball combines the actual needs of the construction of the basic basketball technology teaching course with the actual situation of children, at the same time, it can show a very strong security and convenience, so that users can carry out visual learning in the school’s external network or internal LAN at any time according to the actual situation of children. The network architecture of the system is shown in Fig. 2.

As shown in the figure, the network setting of the visualized teaching system for toddler basketball can be operated either within the local area network or outside the campus network department. It is consistent with the characteristics of basic basketball teaching techniques, and also meets the current environmental conditions for teaching basic toddler basketball techniques. In order to meet the normal operation of the system in different network environments, the system comprehensively designs the network architecture from the campus LAN and the external network. From the perspective of the internal architecture, the server is divided into a database server and a WEB server, and internal communication circulates information through a network switch. Outside
the local area network, if you want to implement the teaching of children’s basketball
courses, you need to enter the teaching system through measures and settings such as
firewalls and VPNs, which include network devices such as switches and routers. In this
data circulation process, all follow the HTTP network protocol.

3 The Hardware Design of Visual Teaching System for Children
Basketball Course

In the visual teaching system of children’s basketball course, the most important one is
the visual interaction module, whose function realization is mainly based on the human–
computer interface. Let children in the use of the software to learn basketball, full of
fun, to achieve human interaction. In the design, the human-computer interaction module
adopts the intelligent display terminal dmt80480507 OSW, which integrates the LCD,
touch panel, data processing unit, storage unit, communication unit, etc. It can realize
the human-computer interaction function quickly and conveniently. Dmt80480507 OSW
user interface is shown in Table 1. Its control mode adopts full duplex asynchronous serial
port, namely RS-232C interface.

| Pin   | Function   | Pin   | Function   |
|-------|------------|-------|------------|
| VCC   | Power supply | DINT  | Serial input |
| GND   | Ground     | DOUT  | Serial output  |
| BUSY  | Buffer full |       |             |

RS-232C is a serial data transmission bus standard for communication between
computers and modems. It is one of the standard interface devices for computers. In the
RS-232C standard, the signal uses a negative logic level, that is, a 3 V—15 V is a logic 1, and a +3 V—+15 V is a logic 0. DMT804805070 OSW implements the standard RS-232C regulations. The logic 1 level is -5 V—7 V, the logic 0 level is +5V—+7 V, and the serial interface of STM32F103ZET6 uses TTL logic level, so the system needs to realize and intelligent display through RS-232 transceiver terminal serial communication.

MAX3232 is a low-voltage differential full duplex RS-232 transceiver. In the range of +3 V—+5 V power supply voltage, only four 0.1 uF external connections are needed to form a dual voltage pump, reaching the highest communication rate of 120 Kbps, fully meeting EIA/tia-232 standard. The pin is as shown in Fig. 3, where C1+, C1, C2+, C2- are capacitor pumps, and the capacitance of the voltage pump is usually 0.1 uF.

![Fig. 3. MAX3232 pin package](image)

Use MAX3232 to realize RS-232-based data communication as the human-computer interaction interface of the embedded system, as shown in Fig. 4.

![Fig. 4. RS-232 drive circuit](image)

On the processor side, the data receiving and transmitting ends Uart4Tx and Uart4Rx of UART4 are connected to T21IN and R20UT of MAX3232 and controlled by the system for serial communication, while T20UT, R2IN of MAX3232 and DMT804805070 OSW’s RS-232 transceiver HMI-RX, HMI-TX is connected to realize RS-232 communication with intelligent display terminal. In addition, because the MAX3232 is a dual
RS-232 transceiver, another RS-232 transceiver is used as a debugging interface in the
design to complete the data communication between the system and the computer, and
to realize the functions of online programming and data storage of the system.

4 The Software Design of Visual Teaching System for Children
Basketball Course

4.1 Visual Data Compression for Basketball Lessons

Teachers can observe children’s learning of basketball technology through the visual
module, and the basketball knowledge in the visual teaching system is mainly displayed
in front of teachers and children through video, text and model. In the system operation,
the above data needs to occupy a lot of system resources. The data compression algorithm
is used to compress the data, reduce the useless use of resources when the system is in
use, and improve the utilization rate of system resources.

Let the compressed data size be $Q_{\text{bit}}$ and divide it into $n$ blocks for compression.
The size of each block of data is $Q_u$, the proportion of $Q_{\text{bit}}$ data is $R_u$, and the block
compression rate is $\alpha_u$. The compressed data size is:

$$
\sum_{u=1}^{n} Q_u \cdot \alpha_u = Q \cdot \sum_{u=1}^{n} R_u \cdot \alpha_u
$$

(1)

Set the read-memory SRAM throughput rate as $V_{\text{SRAM}}$, the decompression module
throughput rate as $V_{\text{dec}}$ (input terminal processing data speed), and configure the interface
throughput rate as $V_{\text{it}}$. Then the actual throughput rate is $V_c$, and the above units are
bit/s. Then the relationship between the above throughput rates can be expressed as:

$$
\varepsilon_1 = \frac{V_{\text{it}}}{V_{\text{SRAM}}}
$$

(2)

$$
\varepsilon_2 = \frac{V_{\text{it}}}{V_{\text{dec}}}
$$

(3)

In the formula: $\varepsilon_1$ and $\varepsilon_2$ are the relationship coefficients of throughput. Suppose the
compression transmission size used by the system is $Q_{\text{bit}}$, the time required for data is
$T_c$, and the acceleration ratio of the data compression configuration is $\kappa$. The speedup
ratio is expressed as:

$$
T_c\kappa = \begin{cases} 
\frac{Q}{V_{\text{it}} T_c} \cdot V_{\text{it}} \leq V_{\text{SRAM}} \\
\frac{Q}{V_{\text{SRAM}} T_c} \cdot V_{\text{it}} > V_{\text{SRAM}} 
\end{cases}
$$

(4)

Data compression function is added in the software design of the system, and appro-
priate acceleration ratio and other relevant parameters are configured to achieve the
purpose of optimal data compression.
4.2 Data-Driven Data Consistency Processing

Data driven technology can drive the change of basketball course knowledge through data and keep the change of basketball course knowledge consistent with the change of data.

Using a data-driven selection collection, Selection is a collection of query filters from a tree-like scene structure, and provides a series of meta operations to manage this collection. Data joins can bind data to the knowledge of children’s basketball courses, allowing data joins to generate corresponding processing sets. These processing sets are important for changes in the structure of the scene and changes in the binding elements. At the Selection level, it focuses on conversion rather than performance. Selection focuses on the binding between data and toddler basketball courses.

Selection provides data operation, which can bind the input data to the selected nodes. The system software design provides standard agnostic processing methods. The user input data is an array with any value as the element. Once the input data is bound to the node element, the meta operations on other selections can be operated by predicate. These operations can set or get attributes, styles, properties, selectors and text content. Generally, by default, the input data and the selected node correspond one by one according to the input data index, and the first node corresponds to the first datum of the input data. When the input data node set needs more accurate mapping, the key method of meta operation can be used to specify the mapping relationship between the input data and the node set, and the matched one will maintain mapping transformation Consistency in the process.

The above process ensures consistency during system data changes. So far, the design of a data-driven visualized teaching system for toddler basketball courses has been completed.

5 The Performance Test of Visual Teaching System for Children Basketball Course

The visualized teaching system test of the infant basketball course adopts a comparative test method, and the system resource consumption level is used as a test standard. The traditional infant basketball course teaching system is referenced and tested under the same test conditions.

5.1 Testing Environment

The system test environment is as follows, the server system is ubuntu15.04, the compiler uses gcc4.9.2, the debugger uses gdb7.9, the browser uses Firefox 37.0, Lenovo desktop computer, Intel Core i5-3470 processor, 4 GB memory, 3.2 GHz frequency. The specific environment is shown in the following figure (Fig. 5).

Before testing the system performance in the above test environment, the system integration test shall be carried out first.
5.2 System Integration Test

The system integration test mainly tests the coordination and integration between the various modules of the infant basketball visual teaching system and the stability of the overall operation of the system to ensure that the system can run normally and stably in the performance test. By using the system’s ability to actually access the data, the system’s blocking ability and pressure can be judged.

The access time of children’s basketball teaching system to network data is shown in the table below (Table 2).

| Times | Time | Whether the block was successful |
|-------|------|---------------------------------|
| 1     | 0.02 | Yes                             |
| 2     | 0.07 | Yes                             |
| 3     | 0.13 | Yes                             |
| 4     | 0.21 | Yes                             |
| 5     | 0.04 | Yes                             |
| 6     | 0.06 | Yes                             |
| 7     | 0.09 | Yes                             |
| 8     | 0.14 | Yes                             |
| 9     | 0.17 | Yes                             |
| 10    | 0.15 | Yes                             |

From the data in the table, it can be seen that the access to the network data of the early childhood basketball teaching system can be blocked in time to ensure the safety of the network data. At the same time, it also shows that the designed visual teaching system of the early childhood basketball course based on the data-driven has good integration
and coordination among all modules, and runs stably and normally to meet the needs of subsequent tests.

5.3 Performance Testing

The system performance test is mainly the system resource consumption test, which simulates the normal use of users and tests whether the system resource consumption is abnormal. The third-party software is used to monitor the resource consumption level of different systems in use. The traditional web-based teaching system test is used to record the results as test result 1. The traditional JSP based teaching system test is used to record the results as test result 2. The designed data-driven visual teaching system for children’s basketball course test is used to record the results as test result 3 (Fig. 6).

![Fig. 6. Performance test results of different teaching systems](image)

Observe the resource consumption of different teaching systems in the figure. Test result 1 shows that with the change of system operating time, its system resource consumption changes significantly. The initial time resource consumption is the largest, reaching 0.9, after reaching a peak, it gradually declines, and after it drops to 0.25, it starts to rise again. Within the time range, most of them are in a state of high resource consumption. Test result 2 shows that the system resource consumption in the first 20 s and 80–100 s of the system operating time changes greatly, and it is in a significant rising stage in the first 20 s, at 20–80 s, although there are some fluctuations, they are basically stable, ranging from 0.5–0.65. Between 80–100 s, there is a significant downward trend; test result 3 shows that during the system operating time, system resource consumption is not Large changes, the fluctuation range is between 0.2–0.3.

Combined with the above data analysis, it can be seen that the system resource consumption level of the visual teaching system for children’s basketball course designed is significantly lower than that of the traditional teaching system, which shows that the visual teaching system for children’s basketball course designed based on data-driven is better than the traditional teaching system.
6 Concluding Remarks

The kindergarten ball sports course focuses on exploring and forming a special course for ball games for all children, and optimizing the content and methods of teaching and learning in the development of ball games to improve teachers’ actual education and teaching level. To promote the overall healthy growth of young children. Designing a data-driven visualization system for children’s basketball courses provides great help for children’s basketball education and learning.

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