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Research on the Instructional Design of Physics Learning Progression Based on "Teaching-Learning-Assessment" Alignment: A Case Study of "Horizontal Projectile Motion"

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Abstract: With the continuous development of new educational assessment paradigm, the alignment of "Teaching-Learning-Assessment" has become a focus of attention. This paper defines the concepts of "Teaching-Learning-Assessment" alignment and "Learning Progression", and analyzes the intersection of the two. Taking the theme of "Horizontal Projectile Motion" in People's Education Press highschool physics as an example, based on the curriculum standard, teachers try to construct a teaching model and assessment framework of physics Learning Progression based on the alignment of "Teaching-Learning-Assessment", to analyze the core literacy of the physics discipline, and to promote the effective teaching and learning in highschool physics classrooms.

Keywords: "Teaching-Learning-Assessment" alignment; Learning Progression; Instructional design

Introduction

In recent years, along with the new round of basic education curriculum reform in China, the goal of the curriculum has changed from "three-dimensional goals" to "core literacy". The change of curriculum objectives brings changes in students' learning styles and teachers' teaching methods, thus triggering changes in classroom teaching. One of the current hot issues is how to adapt to the needs of students' healthy and comprehensive development, teachers' professional development and the continuous improvement of the quality of school operation, and how to build a basic education curriculum valuation system that promotes the development of students, teachers, schools, curriculum and teaching. Realizing the alignment of "Teaching-Learning-Assessment" is the key path to guide the reform of classroom teaching, promote the education of core curriculum literacy and improve the quality of teaching.

1. "Teaching-Learning-Assessment" Alignment to Promote Physics Teaching Changes

The alignment of "Teaching-Learning-Assessment" refers to the degree of coordination and cooperation

of the three factors in the entire teaching system, the teacher's teaching behavior, the student's learning behavior, and the assessment of the bilateral activities of teaching and learning in the entire classroom activities . A clear goal is the premise and soul of "Teaching-Learning-Assessment" alignment, and the realization of "Teaching-Learning-Assessment" alignment depends on the teachers' curriculum literacy and assessment literacy[1]. Since the United States launched the "standards-driven and standards-based" basic education curriculum reform in the 1980s, the issue of alignment in the field of educational research has become a hot topic. Cohen, an American educational psychologist, first put forward the concept of Instructional Alignment, and used this concept to describe the degree of match between the design conditions of teaching and the expected teaching process and teaching results[2]. Subsequently, Webb, a famous American education evaluation expert, conducted a comprehensive and in-depth study and defined the concept of "alignment" [3]. After that, Chinese scholars such as Yunkuo Cui first clearly put forward the "Teaching-Learning-Assessment" alignment, and constructed a theoretical model of "Teaching-Learning-Assessment" alignment [4], which provided a solid basis for subsequent theoretical exploration and applied research on "Teaching-Learning-Assessment" alignment across various disciplines and educational levels. As discussed in Webb's book, the fundamental purpose of striving to realize the alignment of "Teaching-Learning-Assessment" is to better guide teachers' teaching and students' learning. In the physics classroom, assessment is no longer an independent link, is no longer a view of the teacher's teaching behavior and student learning behavior of the bystander status, the implementation of the "Teaching-Learning-Assessment" alignment makes the three interlocked, trinity, and together to promote changes in the teaching of physics and the improvement of the quality of teaching, is of great significance.

2. Learning Progression Ensures the Consistent Implementation of "Teaching-Learning-Assessment"

The concept of "Learning Progression"(LP) was first proposed in the field of science education in the United States in the study of the alignment of the development of students' scientific literacy, the academic community has not yet formed a unified definition . Generally speaking, scholars recognize that the nature of LP is a process of learning development. Further, the LP is a description of a coherent, typical learning pathway that students follow as they learn concepts about the same topic across academic segments, generally presented as a series of interrelated conceptual sequences that unfold around a core concept from simple to complex [5].

LP has five components [5] : (1) Progression Endpoints: learning objectives, generally the next stage of education to determine; (2) Progression Dimensions : generally core concepts within the discipline, tracking the development of students in the progression dimensions can be understood in its overall learning process; (3) Achievement Levels: intermediate steps required to reach desired levels, which reflect general stages in the development of a student's thinking; and (4)Learning Performance : the actual performance of a student at a particular level in accomplishing a variety of tasks, with the purpose of demonstrating that the student has achieved a particular level of achievement; (5) Assessment :used to track the student's development along the expected progression path.

The LP plays a unique role in the alignment of "Teaching-Learning-Assessment" . The LP is a description of the way in which students progress and deepen their thinking as they learn and explore a topic over the course of an academic period [6]. The theory believes that learning is a continuous accumulation, step by step process, which requires the assessment needs to take a clear goal as a starting point, starting from the student's overall development, the student's ability to be divided into from low to high step by step level, in order to provide students with the necessary developmental needs, so that students in the learning and exploration of the subject, deepen the complexity of the thinking and step by step towards the higher cognitive ability to advance, and ultimately reach the end of the progression. The LP coincides with the alignment of "Teaching-Learning-Assessment", which is based on clear objectives and points to effective teaching and learning. Moreover, it can promote its concretization and operationalization, providing support for the construction of a framework for the design of physics LP based on the alignment of "Teaching-Learning-Assessment" . Fully utilizing

the LP theory incoherence can effectively promote the development of students' core literacy in physics and improve the quality of teaching and learning.

3. Cases of Learning Progression Teaching and Assessment Design in Physics Based on the Alignment of "Teaching-Learning-Assessment"

3.1 Content Analysis of the Teaching Materials Based on the Curriculum Standard of "Horizontal Projectile Motion"

The "General Senior High School Physics Curriculum Standards (2017 Edition)" clearly outlines the basic requirements for all students learning "Horizontal Projectile Motion" including the basic requirements for teaching implementation and the norms and key points for student assessment. According to the curriculum standards, the relevant content of the fifth chapter of "Horizontal Projectile Motion" in the compulsory second chapter of Physics of People's Education Press belongs to the knowledge under the theme of "Curvilinear motion and the law of universal gravitation" . The schedule clearly puts forward: through the experiment, students explore and recognize the law of horizontal projectile motion, will use the method of synthesis and decomposition of motion to analyze the horizontal projectile motion, the experience of decomposition of complex motion into simple movement of physical thought, can analyze the horizontal projectile motion in the production of life.

In general, the requirements of the new standard for this chapter is to be able to recognize the characteristics of the physical model of horizontal projectile motion. Students through the study of horizontal projectile motion form of motion, the experience of physics in the experimental or theoretical derivation of the method, as well as to simplify the research method, can use evidence to explain their own views, can be on the curvilinear motion of some of them is perceptions put forward to question the characteristics of horizontal projectile motion will do to explore experiments. Be able to identify the physical quantities to be measured in an experiment and thus design an experimental program . Students will use the provided experimental equipment to carry out experiments and obtain data, discover the characteristics through the analysis of the data, and then summarize the experimental conclusions and try to explain them. Be able to write a simple experimental report.

3.2 Progressive Models Design of the Core Concept of Horizontal Projectile Motion

According to the theory of LP, based on the alignment of "Teaching-Learning-Assessment", the design of physics LP teaching needs to take into account the developmental level of students' cognitive structure, and formulate the progression teaching objectives from low stage to high stage, from simple to complex. According to the conceptual understanding and thinking level of students in different learning stages, the LP of horizontal projectile motion can be divided into five levels, as shown in **Table 1**.

Table 1. Progression Model of the Core Concept of "Horizontal Projectile Motion"

Progression Level	Progression Level
Level 1 (Starting Point)	Has a vague understanding of horizontal projectile motion, builds a perceptual knowledge of projectile motion from everyday phenomena, but lacks a correct understanding of the laws of projectile motion.
Level 2	Understands projectile motion, especially horizontal projectile motion; knows that horizontal projectile motion is a special type of curved motion, clarifies the concept of horizontal projectile motion, knows that the initial velocity is horizontal, only the vertical direction is affected by gravity, understands that the trajectory is curved, and constructs a physical picture of projectile motion, but lacks scientific thinking and methods to explore the laws of horizontal projectile motion.
Level 3	Qualitatively explores the special curved motion of horizontal projectile motion using the method of synthesis and decomposition of motion, applying scientific thinking to simplify complex problems.
Level 4	Quantitatively explores the laws of horizontal projectile motion through the experiment "Exploring the Characteristics of Horizontal Projectile Motion," designs experiments, conducts experimental exploration, plots experimental graphs, records experimental data, calculates, and derives quantitative laws of horizontal projectile motion based on qualitative exploration.
Level 5 (End Point)	Capable of handling more complex projectile motion, can analyze projectile motion in everyday life; experiences the scientific inquiry process, masters the laws of projectile motion, flexibly applies these laws to solve problems, develops scientific thinking habits, emphasizes the essence of physics; through activities such as observation, experiment and inquiry, communication, and discussion, cultivates a respect for objective facts, a realistic scientific attitude, enhances innovation awareness, and practical ability.

3.3 Learning Progression Assessment Design of "Horizontal Projectile Motion"

Learning progress assessment is the key to reflect the alignment of "Teaching-Learning-Assessment", but also an important component of the learning progress teaching design, should always be throughout the teaching and learning, so that the combination of formative assessment and summative assessment[7]. According to the constructed progression model of the core concept of projectile motion, the assessment framework can be constructed from progression activities, progression goals and assessment points, as shown in **Table 2**.

Table 2. Progressive Assessment Framework for Learning "Horizontal Projectile Motion"

Progression Level	Progressive Activities	Progressive Goals		Key Assessment Points
		Constructing Physical Concepts	Constructing Physical Concepts	
Level 1	Observe and describe projectile motion phenomena in everyday life; brainstorm and provide examples of similar or related motions.	Begin studying motion and force; review and reinforce the concept of curved motion.	Stimulate divergent thinking; strengthen association and transfer skills.	Can the student relate and answer questions about motions such as shot put and javelin throw in sports?
Level 2	Analyze and summarize the characteristics of projectile motion from the perspective of object motion.	Summarize that projectile motion has an initial velocity, and the trajectory is a curve.	Analytical and summarization skills.	Can the student analyze and summarize the characteristics of projectile motion from the perspective of object motion?
	Analyze and summarize the characteristics of projectile motion from the perspective of forces acting on the object.	Summarize that the object is affected by gravity and air resistance.	Analytical and summarization skills.	Can the student analyze and summarize the characteristics of projectile motion from the perspective of forces acting on the object?
	Derive the characteristics of the motion and forces of an object in horizontal projectile motion based on the characteristics of projectile motion.	Reason that the initial velocity is horizontal, and the object is only affected by gravity (neglecting air resistance).	Logical reasoning from general to specific; ideal model thinking by focusing on major factors and ignoring minor ones in physical problems.	Can the student understand the concept and laws of projectile motion and derive the concept and laws of horizontal projectile motion from general to specific, and initially establish the physical model of horizontal projectile motion?
Level 3	Study complex horizontal projectile motion based on the composition and decomposition of motion in curved motion.	Vertically, the object is only affected by gravity and undergoes free fall; horizontally, it is not affected by forces and undergoes uniform linear motion.	Scientific thinking that simplifies and clarifies complex problems.	When faced with new physical scenarios, can the student use existing knowledge of linear motion to solve complex horizontal projectile motion problems?
Level 4	Conduct a quantitative exploration of the laws of horizontal projectile motion through the experiment "Exploring the Characteristics of Horizontal projectile motion."	Experimental exploration to verify the qualitative laws derived.	Scientific inquiry skills.	Can the student design and complete an exploratory experiment, correctly process data, plot graphs, and derive the laws of horizontal projectile motion?
Level 5	Analyze more general cases of projectile motion in everyday life, specifically projectile motion with a non-horizontal initial velocity.	Derive the laws of general projectile motion and apply these laws to analyze real-life problems.	Transfer skills from specific to general; scientific attitude of relating physics to everyday life.	Can the student handle more complex projectile motion and analyze projectile motion in everyday life, establishing a physical model for general projectile motion?

Conclusion

Constructing a physics LP based on the alignment of "Teaching-Learning-Assessment" is a process of alternating theory and practice. It is a process of

alternating between theory and practice, in which theoretical models are constructed to guide teaching practice, and theoretical frameworks can be constructed in teaching practice that are more consistent with students' learning, alternating and developing continuously. This paper analyzes the curriculum standards, teaching materials, and students' cognitive level, and designs a framework and case study of physics LP based on the alignment of "Teaching-Learning-Assessment", which is centered on the core concept of projectile motion, and we hope to provide suggestions and references for physics teaching.

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