

# Innovative Research on Backward Design in AI Course Development for Application-Oriented Universities in Hainan

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**Abstract:** Urban-rural planning and design courses applied at application-oriented universities in Hainan often encounter issues like complex projects and poor feasibility of students' proposal due to the traditional forward teaching (linear by knowledge points) that is disconnected from training and job demands. By taking Taking Backward Design as logic, analyzing its three stages progressive mechanism, clarifying instrumental/procedural/optimizing knowledge structure and corresponding capability orientation combined with practical needs on protection and renewal of Hainan's arcade buildings, tropical residential area design, and rural planning, we construct a course model: extraction of expected outcomes; sequential setting of assessment evidence chain; reverse generation of learning activity; propose a dual-track embedding mechanism, dynamic spiral organization sequence, formative assessment driven closed-loop iterative scheme that can provide an operable structural path for development of planning and design courses in regional application-oriented universities.

**Keywords:** Backward Design; Urban-Rural Planning and Design Course; Arcade Building Renovation Design; Application-Oriented Universities in Hainan; Course Development.

## Introduction

Design courses of the urban-rural planning major have an important function in nurturing application-oriented talents: whether or not the graduates would be competent with skills on performing practical tasks (such as site investigation, scheme conception, result expression) upon entering into work. Especially for application-oriented universities in Hainan, we need local practitioners capable of handling tasks like arcade building protection, tourist town renewal, and tropical residential area planning. Many design courses adopt the forward logic of "teach principles first, practice techniques secondly, do design projects last", making students being at a loss facing complicated social, economic, and climatic conditions during real projects. Take the arcade renovation projects for instance, what enterprises need are graduates that could survey historical buildings, evaluate structural safety, propose feasible renovation schemes, and draw detailed construction details – not just those who can simply recite architectural history terms. We need to introduce Backward Design starting from the terminal design outcome and ability requirement and deduce course objectives, assessment methods, and teaching activities in reverse. This paper has research significance by taking the arcade renovation design course as the main line, clarifying the adaptive mechanism of Backward Design in planning and design courses, building a design course model and content innovation framework orienting towards Hainan's regional characteristics, providing transferable reference to similar institutions.

## 1. The Internal Logic of Backward Design and the Adaptive Mechanism for Planning and Design Courses

### 1.1 The Three-Stage Progressive Logic of Backward Design

The idea behind Backward Design is based on the backward logic: start from the end in mind. First step clarifies the expected learning outcomes - it requires a precise definition of what are the design outputs that students should be able to achieve upon completing the course (e.g., complete the facade mapping and damage analysis of arcade buildings, propose two or more functional replacement

schemes, draw detailed construction details meeting preservation requirements); second step defines assessment evidence – determines beforehand how one will judge if the outcomes have been achieved. Usually, this step relies on empirical carriers close to professional practice when designing planning and design courses (phased drawings, working models, research reports, presentation performances), etc.; third step reverses generation of learning activities. Teachers deduce backward the specific training steps necessary for the assessment requirements (site survey, software operation, case analysis, scheme comparison and selection).

The constant review and recalibration of this three-step cycle (expected outcomes to assessment design and finally to activity arrangement): each one needs to be reviewed backwards checking its consistency with the initial objectives. If we expect students to independently perform the protective renovation design for the facades of arcade buildings, our assessments need to contain full sets of drawings from on-site images and damage annotation up to renovation methods while the teaching activities should focus on key skills like surveying methods, identifying damage types or choosing materials. The backward structure keeps the course anchored in terminal performance all along, avoiding the dilemma when teachers show many cases but students can't handle real projects.

### ***1.2 Knowledge Types and Capability Orientations of Planning and Design Courses in Application-Oriented Universities***

Application-oriented planning and design courses emphasize the practicability of "learning for immediate application" in which there are three kinds of knowledge compositions: instrumental knowledge including surveying (total station and laser distance measurement), drafting and modeling (CAD and SketchUp) and fabricating physical models, focusing on transforming immediately into mapping and presentation; procedural knowledge being the whole design process from site investigation, status analysis, concept generation, scheme development up to final presentation, requiring a clear understanding of work connotations and delivery requirements at every step; optimizing knowledge involves constantly refine schemes under various constraints such as structural limitation, cost control, or aesthetic guidelines, it requires specific adjusting strategy such as visual examination of arcade colonnade proportion, comparison choice of paving material performance, integrative equipment concealment with facade design etc., these three kinds of knowledge moving vertically until leading to the comprehensive solution of implementable design problem<sup>[1]</sup>.

We have likewise developed a corresponding set of such capabilities for these three key abilities: field investigation ability (ability to enter real urban blocks according to task requirement and collecting first-hand environmental and usage data via observation, surveying, and interviews), professional expression ability (to convert research information into standard plans, elevations, sections, and analytical drawings) and design communication ability (expressing design logic in scheme presentation and effectively answering questions from both teaching team and industry reviewers). These abilities do not depend on grand theories but instead are built upon solid hands-on habits and problem decomposition thinking which match well with job competency requirements of local design institutions and construction management departments in Hainan.

### ***1.3 Adaptive Support of Backward Design for the Development of Planning and Design Courses***

The inherent characteristics of design teaching is reiterated as "reciprocity between ends and means", but traditional forward courses usually arrange site analysis, environmental behavior, morphological composition and regulatory provisions in such an order that it will reach its end when students enter into the substantive scheme development phase. Backward Design begins from the expected terminal results: making the teacher firstly defines what kind of design tasks should be completed for students (for example, generate a street-block renewal scheme that preserves the traditional facade character of arcade buildings yet incorporating modern commercial-residential functions and facility systems) therefore the contents of this course could focus very well on the core task, decisively compressing the background theories with little relevance and keep only indispensable methods and skills, avoiding dissipating teaching due to accumulating too much knowledge<sup>[2]</sup>.

Another problem about the authenticity of assessment methods. Planning and design abilities cannot be tested by paper-and-pencil tests, perfectly matching the idea of setting assessment before determining activities (Backward Design). Teachers can construct an evidence chain throughout the semester on a full arcade renovation project: They will present their building condition assessment reports in the second week, finish their spatial function bubble diagrams and rough models in the fifth

week, submit a scheme plan after structural comparison in the ninth week, and do a formal panel presentation in the fourteenth. And this assessment framework itself serves as a verification mechanism for the course objectives -- if some expected outcome does not match any specific design deliverable, then it's because we set our objective too vaguely and need to revise it retroactively. Such a self-correcting mechanism allows the design course having higher degrees of dynamic regulatory flexibility that overcome the common shortcoming of "ambitious project objectives but vague generation of student competencies."

## **2. Construction of a Backward Design Model for Design Courses Oriented to Hainan's Regional Characteristics**

### ***2.1 Extraction of Expected Outcomes Driven by the Needs of Arcade Renovation in Hainan***

Extracting expected outcomes means converting the key competencies for local planning and design practices in Hainan into a series of design tasks that can be done step by step. Typical practical tasks at historic arcade districts in Haikou and Wenchang such as surveying and mapping facade deterioration along the streets; change function from single residential use to mixed commercial-residential or cultural and creative workshop uses; adapt ventilation and shading according to tropical hot and humid climate; protect and do contemporary reinterpretation of decorative components etc., decomposed from real world tasks we could extract some common operating steps: accurately get spatial dimensions and existing conditions within the built environment, propose functional adjustment strategies with reference to historical context and client's needs, make implementable drawing scheme under constraint of preservation planning, check spatial atmosphere via physical models or digital renderings<sup>[3]</sup>.

Avoid goal deviations from terminologies too. Different projects may have different terminology for the same kind of design task (organic renewal / style continuity), however they share common design behaviors, which are summed up into four steps: surveying-mapping, assessment, scheme development, and construction drawings. We suggest use action + object + condition format to uniformly express expected results; e.g., under the given surveying data of the arcade building cluster and the constraints of preservation planning, complete a renovation scheme covering functional replacement, circulation optimization, and facade restoration, and draw a 1:50 detailed partial drawing. Stripping off the context shell of specific projects, we keep transferable design behaviors so that our course objectives will focus on the three basic modules of site cognition, scheme deliberation, and detailed expression, thus guaranteeing a high level of alignment with local employment needs.

### ***2.2 Sequential Setting of the Multi-Dimensional Assessment Evidence Chain***

Assessment evidence chain links all students' design output through the semester sequenced for verification of achievement status of specific expected outcomes. First step of sequential setting matches at least one type of collectible assessment evidence per expected outcome (site investigation notes, architectural survey drawings, functional analysis sketches, conceptual model photographs, phased review records, final presentation boards), then sequentially sequence them by increasing complexity considering cognitive and operation difficulty forming a strict inheritance relationship in skills: e.g., evidence from the second week contain a set of current condition photos of arcade buildings and preliminary survey sketches; fourth week have CAD floor plans and facade damage annotation drawings based on the survey data; sixth week have functional zoning bubble diagrams and spatial reorganization strategies completed on the basis of the previous work.

Time span and difficulty progression cannot be over an acceptable limit for pieces of evidence. Two critical design reviews too far apart will make it hard for those who diverge halfway to get corrected on time. Better to have "evidence packages", with two to three week interval, containing one phased drawing submission, one group discussion record and a short design reflection statement, gradually building into a whole project portfolio by the end of the semester. It gives diagnosis as well -- if there is poor quality in any given piece of evidence package, teachers can quickly find out what this comes from (the "site investigation" stage or the "scheme deliberation" stage), thus enabling them to intervene in small scales at different teaching juncture before problems pile up till being exposed during the final review<sup>[4]</sup>.

### ***2.3 Rules for the Reverse Generation of Learning Experiences and Teaching Activities***

Reverse Generation Rules: Take the pre-determined assessment tasks, ask in reverse what ability do our students have allowing them to accomplish those tasks and map all these abilities onto individual teaching activities. E.g., if an assessment task is "to complete a renovation design drawing for the street-facing facades of arcade buildings based on measured data and preservation guidelines", we may deduce in reverse that the prerequisites skills are like: reading historical building survey drawings; identify different types of deterioration; understand the basic properties of restoration materials; master the common construction details for facade decoration; skillfully use drafting software for layered expression... Five skills will lead us to create five small teaching activities (distinguishing deterioration types by color on printed survey drawings) etc.

Time spent in each teaching activity has to be matched with the value weight of the assessment task within the course when we do reverse generation; it's not appropriate if the assessment task takes up a small proportion, yet requiring students spending much time on solving complicated prerequisite exercises. No single teaching activity exceeds half an hour or one hour. A "relay" exists between them – output document of previous activity becomes the foundation of next activity (e.g., students import their self-drawn floor plan into the modeling software as the base map for massing studies so that they can clearly see how every step leads towards the progression of the final scheme rather than doing scattered and unrelated exercises), basically turning the design course from being a "collection of discrete instructions" into becoming a "complete climbing path from cognition to performance", all the steps are clearly connected to the final arcade renovation design result.

## **3. Content and Structural Innovation of Planning and Design Courses Driven by Backward Design**

### ***3.1 Dual-Track Embedding Mechanism of Modular Course Content***

Dual Track Embedding Mechanism splits course content into 2 tracks (design methods and techniques track and project practice track), advancing simultaneously yet interlocking at some junctions: The Methods track contains hard skills such as site investigation methods, architectural surveying and drafting standards, principles of spatial composition, and basic knowledge of materials and construction are logically organized according to the design process; The Practice track is guided along the main line of the real arcade renovation task, advancing together with the project process ("preliminary investigation-initial concept-scheme development-detailed design-result expression"), both tracks don't teach then apply but advance in parallel every week – the methods track will teach building value assessment and condition analysis methods, the practice track requires immediate completion by students of corresponding operations in the designated arcade street blocks, instantly coupling knowledge input and design output<sup>[5]</sup>.

To avoid their disconnection, we use the "scenario-triggered task" as anchor point for both tracks: The task originates from the practice track; they have to immediately apply the skills learned by the methods track of this week to solve it right away. For example, after learning facade surveying and deterioration recording techniques for arcade buildings in the methods track, the practice track will assign a group task which is to do field measurements on a continuous arcade facade, mark the cracks, spalling and water seepage areas and draw a deterioration distribution map based upon the given legends. Shorten the "conversion path" from "learning to application", thus there's no need for teachers to further introduce the application value of the knowledge points because the scenario task is its most direct proof.

### ***3.2 Dynamic Spiral Course Organizational Sequence***

Some important design skills in dynamic spiral organization appear differently at different layers over the course with increasing depths - it is a layered path that builds up competency. 3-4 core competencies (site and context interpretation, spatial and functional reorganization, detail and material expression), complete one spiral ascent before/during/after this course. Pre-course phase: Study the basic knowledge about arcade buildings by yourself via online resources, collect renovation cases, do low difficulty case imitation and analysis; In-course phase: Do rough model deliberation, scheme comparison and selection under the guidance of the teacher, multiple rounds of design reviews -- the second spiral layer; Post-course phase: Refine your schemes based on review feedback and write

design reflection reports, do a self-review of the whole design process--the third spiral layer. The spiral builds upon each other, and the openness, comprehensiveness, and autonomy decision making weight of tasks increase gradually with every layer<sup>[6]</sup>.

For example, regarding the competency of "site and context interpretation", we set the first one as the pre-course stage (students just need to check the materials and write down a simple cognitive report about the arcade district with brief texts and images); the second one as the in-course investigation stage (entering the site for detailed surveying, analyzing street dimensions, facade rhythms and current usage condition; producing systematic site analysis drawings); the last one running through the scheme development and presentation defense stage (explaining in their presentations how the design responds to the context and making evidence-based adjustments based on reviewers' queries). Students have plenty of time to digest various aspects of the same competency which avoids them from falling behind due to excessive difficulty jumps. Dynamism of our course is also reflected by the fact that after every spiral, teachers can fine-tune the emphasis and depth of the next round depending upon the class' average performance so that teaching will always stay within students' zone of proximal development.

### ***3.3 Formative Assessment and the Closed-Loop Triggering Design for Course Iteration***

Formative assessment doesn't give final outcomes score but gives small-sized checkpoints all over the whole process (before/during/after), with every checkpoint giving some recordable evaluations. The core of our closed loop triggering design is the setting up of a response chain: data-diagnosis-adjustment - three trigger lines are set to drive teaching intervention- in case that the overall attainment level of a certain phased design review task is relatively low, we know the teaching activities related to this task should urgently reinforce; if there is a certain kind of problem happening repeatedly among more than half of the students' drawings—proportion of colonnades being disproportionate, or non-standard expression of details—we know the instruction or demonstration method on the relevant knowledge needs adjusting; if the scores from three consecutive checkpoints has shown a downward trend, we know the difficulty/pacing of next content must be re-assessed. Three trigger lines just requires judgment by teacher via review records and brief indicator checkmarks, no need for any complicated statistical tools.

The iterative actions after triggering should be pre-planned as templates to respond promptly. For example, if there's a low level of attainment: teachers could add a "corrective workshop" in the next teaching unit to re-clarify important points by comparing right and wrong examples; if it's common mistakes: teachers will record demonstration videos under 15 minutes for students to watch again and do some short exercises correcting the relevant part of their drawing; if there's a downward trend: teachers need to change the requirement of the following tasks (e.g., break down the complex spatial design tasks which are completed individually at first into guided tasks with step-by-step prompts to reduce cognitive load) etc. The closed loop mechanism only replace/compensate within a small scope without touching the basic framework of the course, making course iteration become an operable and traceable routine practice. Instead of having vague overall impression to make adjustment after every round of teaching, teachers can carry a clear list of changes into the next cycle.

## **Conclusion**

In this paper, we systematically study the innovative use of Backward Design in urban-rural planning and design courses applied in application-oriented universities in Hainan from three levels (internal logic, model construction, and content and structure): firstly explaining the three-step progressive relationship of Backward Design and its adaptive support for the knowledge types and capability orientation of design courses, defining the course development logic of terminal outcomes first, teaching process second; Secondly establishing a course design model focusing on regional needs such as the protection and renewal of arcade buildings in Hainan: rules for extracting expected design outcomes, sequential setting assessment evidence chain, reverse-generation method of teaching activities makes a clear correspondence with course objectives to local planning and design job tasks; last proposing a dual-track embedding content organization mechanism, dynamic spiral course sequence between the pre-course stage, in-course stage and post-course stage, formative assessment driven closed-loop iterative scheme, innovate both in course structure and operation mechanisms. Propose studying resource adaptation conditions for implementation by application-oriented universities of different scales and conditions using this model, developing supporting tools for collection and analysis of process-based design data, applying this design logic to the thematic

integration of other planning courses including rural revitalization planning and urban renewal design in our future works.

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### **References**

- [1] Wang Xinyu. "Exploring Strategies for AI-Empowered Teaching Reform of Computer Courses in Higher Vocational Education." *Computer Knowledge and Technology*, 22.03(2026):161-163.
- [2] She Yudan. "Research on Backward Design of AI-Empowered College Computer Basic Courses." *Computer Knowledge and Technology*, 21.33(2025):157-160.
- [3] Wang Fanglei, and Qu Yanhong. "Analysis and Future Prospects of Backward Design Research Based on CiteSpace." *Basic Education Research*, .02(2025):17-21.
- [4] Mi Yiyi. "Backward Design: Iterative Transformation of Instructional Design." *Jiangsu Education Research*, .07(2024):63-66.
- [5] Wu Xuan. "Practice and Reflection on Backward Design of 'Machine Learning' Teaching in Artificial Intelligence." *China Information Technology Education*, .15(2024):53-55.
- [6] Hu Xuanping, et al. "Analysis of the Connotation and Characteristics of Backward Design Oriented to Core Competencies." *Teaching and Administration*, .09(2022):85-89.