Constructing a Live-Streamed Instructional Ecosystem in Open Education for Grassroots Governance Personnel Development

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Abstract: *Live-streamed instruction has become an important mode of synchronous teaching and learning support in open education. Existing studies have focused on platform applications and instructional models, with limited attention to systemic relationships among actors, resources, technologies, and environments. For grassroots governance personnel, it must address the distinctive circumstances of employed adult learners: work-study tensions, varied prior learning, and practice-oriented needs. This study draws on the theory of educational ecology to construct an analysis framework for the live teaching ecosystem aimed at cultivating grassroots governance personnel. The study defines the connotation of this ecosystem and its four components, namely actors, technology, resources, and environment, analyzes the relationships and structural characteristics among the elements, explains the three operational mechanisms, namely information exchange, input to effectiveness transformation, and feedback regulation, and proposes five optimization paths, namely contextualization of resources, complexification of teams, flexibility of organizations, full-process support, and capability of evaluation. Live teaching should go beyond synchronous teaching and move towards an ecosystem where actors, resources, technology, and environment operate collaboratively. By organizing learning around governance tasks, providing full-process learning support, and relying on data-driven feedback and adjustment, such ecosystems can effectively cultivate grassroots governance capabilities. Accordingly, this study offers a systematic theoretical and practical framework to promote this goal.*

Keywords: *open education; live-streamed instruction; instructional ecosystem; grassroots governance personnel development*

Introduction

Although teaching organization in open education has undergone several rounds of technological transformation, certain long-standing challenges remain unresolved, such as the highly dispersed geographical distribution of learners, prominent conflicts between work and study, and the limited reach of face-to-face instruction. With the continuous advancement of live streaming technology, its advantages in real-time instruction, remote coverage, and interactive feedback have become increasingly evident, making live-streamed teaching an essential means for delivering synchronous support in open education.[1-2]

The literature falls into three strands: live-streamed instruction in open education (platform applications, blended models, live interaction)[2-3]; open education for rural revitalization and grassroots personnel (training models, curricula, learning support)[4-5]; and educational ecology and smart learning environments (systemic relationships among actors, technologies, resources, environments)[6-8].

Existing research on live-streamed instruction focuses on particular technologies and models while relationships among system elements were neglected. Research on grassroots personnel development concentrates on training models and curricula, with limited analysis of live-streamed instruction's dynamics. Although educational ecology has substantial theoretical foundation, it has not adequately explained how live-streamed teaching functions for this distinctive group of adult learners.

In this context, this study focuses on two core issues. One is what elements constitute such ecosystem. The other is through what mechanisms they operate collaboratively to build governance capacity. To address these questions, this paper draws on educational ecology as the theoretical basis and constructs an analytical framework to explore the conceptual connotation, constituent elements,

relationship structure, operation mechanism and optimization path of this ecosystem.

1. Theoretical Foundations and Constituent Elements of the Live-Streamed Instructional Ecosystem in Open Education

1.1 Defining the Live-Streamed Instructional Ecosystem in Open Education

Educational ecology provides a suitable analytical perspective for understanding live teaching in open education. The key point is that educational activities are not isolated, but in an ecological situation composed of actors, resources, technology and institutional environment, and the elements are always interacting with each other. Live teaching is a typical manifestation of this systematic feature. Teachers, learners, technology and knowledge resources are in the same teaching situation. Any change in any of these elements will drive other elements to make adjustments. For example, whether the platform is stable will affect the teaching rhythm, the learner 's feedback will change the teaching method, and the organization of resources will shape the level of participation. Therefore, the introduction of educational ecology can make the research no longer only focus on the isolated technology itself, but turn to examine how the components of each system depend on each other and adapt to each other in the whole teaching process, so as to provide a more comprehensive understanding of live teaching in practice.

This study defines the live teaching ecosystem in open education as a dynamic system, which consists of the following elements, actors, including teachers, learners and support personnel; live broadcast platform and digital technology; curriculum materials and generative resources; and institutional environment, organizational environment and learning environment. The system is formed and continues to operate through interaction, resource exchange and feedback regulation, and has three basic characteristics: First, systemic dependence, that is, any change in any element will cascade to the entire system. Second, dynamic interaction, that is, in a changing environment, the operation order is maintained by feedback and adjustment. Third, openness and adaptability, that is, the overall effectiveness of the system depends on the coordination between the various elements, rather than the optimization of a single element.

1.2 Core Elements of the Live-Streamed Instructional Ecosystem in Open Education

Drawing on educational ecology and considering both the technological features of live-streamed instruction and the institutional attributes of open education, this study identifies four dimensions, including ecological actors, technological ecology, ecological resources, and ecological environment[9]. Ecological actors include lecturers, tutors, learners, learning center managers, technical support personnel, and grassroots practitioners involved. The instant interaction between them constitutes the most active teaching communication channel in the ecosystem. Technological ecology refers to the infrastructure of live teaching, such as platforms, learning systems, mobile devices, data analysis tools and network infrastructure. Its performance and availability shape the form and depth of teaching interaction. Ecological resources are composed of knowledge content and learning materials circulating in the teaching process, including teaching materials, courseware, policy documents, cases, real governance issues, learners ' practical experience and live interactive content. Among them, the experience accumulated by grassroots learners is an important emergent resource. By integrating these resources, a continuous knowledge flow is formed within the system. The ecological environment refers to the external conditions of the operation of live teaching, covering three levels : system, organization and learning. The institutional level includes the mission of open education, the evaluation system and the distance education policy. The organizational level covers the support of universities and learning centers, the attitude of employers to on-the-job learning, and the time constraints in grassroots work ; the learning level involves regional digital infrastructure, network access conditions and learning space. These three levels extend from the macro institutional situation to the specific situation around the learners, which together constitute the ecological background of live teaching.

In this configuration, actors initiate teaching, resources determine learning content, technology empowers interaction and support, the environment defines system boundaries, and the interaction between various elements together generate the actual effect of live teaching. As far as grassroots personnel are concerned, these elements need to be reconfigured to meet the characteristics of open education learners and their professional competence requirements.

1.3 Specific Requirements of Grassroots Governance Personnel Development

Serving grassroots governance personnel is a distinctive advantage of open education, whose learners are mostly employed adults working on the front lines of grassroots governance, especially in subdistricts and townships. Their learning has four characteristics. Firstly, the learning time is restricted by the demands of grassroots work. Secondly, there are differences among learners in terms of age, educational background, and digital literacy. Thirdly, they have rich practical experience. Fourthly, their learning motivation is closely related to solving practical problems in the workplace. These conditions pose challenges for teachers. Teachers not only need to possess subject-specific knowledge but also need to understand the grassroots governance context and have the ability to transform practice into cases, extract problems, reproduce scenarios, and guide application. Currently, there is still a gap between some teachers' teaching experience and grassroots frontline practice.

The core objective is to enhance learners' ability to apply their professional knowledge to analyze and solve practical governance problems. Therefore, the live-streaming resources must include content related to policies and oriented towards practice, so that the teaching can promptly respond to the problems and situations in grassroots work. However, the issues covered by grassroots governance are extensive and the knowledge boundaries are unclear, which poses a challenge to the organization of teaching content and the development of resources. Learning is also influenced by employers, local learning centers, peers, and network conditions. These are important external conditions for maintaining continuous participation. These characteristics require three shifts: from textbook chapters to governance-task-based learning; from two-way interaction to multi-actor collaboration; and from synchronous-only support to pre-class, in-class, and post-class support. A generic live-streamed instruction model thus cannot be transferred here without adaptation.

2. Element Relationships and Structural Characteristics of the Live-Streamed Instructional Ecosystem

2.1 Interaction among Ecological Actors and the Reconfiguration of Roles

In live teaching, the roles of teachers and learners are different from those in conventional face-to-face teaching. Teachers need to design courses, create inquiry scenarios, organize interactions, integrate resources, and provide feedback. Their role has expanded from a one-way transmission to an overall coordinator of multi-directional interaction. Real-time classroom regulation directly affects the quality and depth of teaching. Learners need to engage in autonomous learning, express experiences, participate in case discussions and transfer knowledge to practice. Their role has shifted from passive recipients to active participants. Learning effectiveness largely depends on the degree of cognitive investment and participation willingness. This role reconfiguration is a structural change driven by live teaching technology, rather than merely a change in the functional level of the actors. In large-scale remote scenarios, teachers' perception of the learning status is not as direct as in face-to-face teaching. Therefore, teaching design must focus on stimulating learners' willingness to participate and their awareness of autonomous learning.

For grassroots personnel, actor interaction becomes more complex. Instructors should organize teacher-learner interaction around policy interpretation and governance problems; prompt learners from different villages and communities to exchange experience, enabling learner-learner interaction; and guide application of live-session learning to workplace problems, creating learner-practice interaction. Actor interaction is thus a bidirectional, often multidirectional, process of cognitive construction rather than one-way transmission. Real-time Q&A, case discussions, and experience sharing are the principal channels for knowledge circulation. Its value lies not only in increasing classroom activity, but also in sharing experiences and jointly constructing knowledge.

2.2 Coupling between Technological Ecology and Instructional Activities

The teaching value of live broadcast technology lies not in the technology itself, but in whether it can be deeply integrated with teaching design and learning activities. Technology and teaching have been closely intertwined to jointly promote the continuous evolution of teaching models. This coupling is reflected in two interrelated levels : on the one hand, the technical conditions determine the possibility of interaction, data collection and resource presentation ; on the other hand, instructional design determines whether these technical functions can be transformed into substantive learning

activities. The stability and ease of use of technology directly affect the continuity of teaching and learning experience, and frequent technical failures will weaken learners ' trust in distance learning. At the same time, the continuous upgrading of technology is also promoting teaching innovation, prompting live teaching to gradually expand from knowledge transfer to interactive discussion, instant feedback and situational learning. Therefore, this coupling is not a mechanical superposition of technology on teaching methods, but an organic integration through the reform of teaching design. The same tool in different design framework, often produce very different teaching effect.

For grassroots personnel, the imbalance of digital literacy has brought about realistic tension : learners have significant differences in equipment use experience, network access conditions, and platform operation proficiency. In response to this problem, the platform should optimize mobile access and simplify the login process to reduce the threshold of use. In addition, the coupling of technology and teaching is also reflected in the data level. The learner behavior data generated by the platform, such as viewing time, interaction records and task completion, can be transmitted to the teacher in real time as teaching feedback, and through this two-way loop, promote the continuous adjustment and improvement of teaching methods and technical means.

2.3 Hierarchical Structure and Functional Differentiation

In the vertical dimension, this ecosystem presents a 'micro to meso to macro' hierarchical structure. At the micro level, it refers to a single live teaching and its interactive process, focusing on the teaching of specific knowledge units and real-time Q&A. At the meso level, it covers a complete course and its overall organization before, during and after the live broadcast. The purpose is to ensure the coherence of the knowledge system and promote the continuous learning process. At the macro level, it is composed of professional curriculum planning, live teaching coordination at the college level and quality assurance system to ensure the overall achievement of educational goals. These three levels are not isolated from each other. Information feedback and resource flow integrate them into one, micro-level teaching experience, through teacher reflection, is transformed into meso-level strategy adjustment ; the teaching activities at the meso level are guided and constrained by the professional design at the macro level.

These three levels perform their respective duties and are related to each other through continuous information feedback. The primary function at the micro level is real-time interaction and situational awareness. Teachers adjust the teaching rhythm in time according to online interaction, evaluation results, comments and messages, and learning data. The feedback at the classroom level should serve the adjustment at the curriculum level ; the empirical basis of curriculum implementation is further integrated into the quality improvement at the professional level and the institutional level. The effective connection between the various levels depends on the efficient flow of information : macro decision-making must absorb feedback from the meso and micro levels, and micro activities must implement the intention of curriculum design at the meso level. Therefore, the efficient operation of vertical information flow supports the overall efficiency of the entire ecosystem.

3. Operating Mechanisms and Optimization of the Live-Streamed Instructional Ecosystem

3.1 Instructional Information Exchange and the Translation of Learning Engagement into Outcomes

The real-time live teaching system operates by continuously exchanging teaching information and transforming learning participation into learning outcomes. The information flow includes the transmission of knowledge between teachers and students, learners' questions and feedback, as well as the sharing of experiences among learners. In the real-time open education context, the separation of time and space constitutes an obstacle: physical distance weakens non-verbal communication, making interaction less rich than face-to-face interaction. Real-time chatting and discussion forums serve as feedback channels, while voting and quizzes collect real-time data on the learners' status. These functions partially compensate for the limitations of the information flow. The key lies in how participation is transformed into outcomes: the preparation of the teacher, the time investment of the learners, and the technical support, ultimately all must promote the development of the learners' cognitive structure and the construction of their ability system.

Since lower-level learners have to balance work and study, the transformation of participation into results is often constrained. Their participation is often intermittent and fragmented due to work tasks,

which weakens the continuity of knowledge acquisition. One approach is to enhance the situational fit of live teaching: the closer the content is to the actual governance tasks, the easier it is for learners to connect their existing experience with new knowledge, promoting transfer and establishing a transformation chain of "real tasks - live learning - workplace application". Therefore, its value lies not only in the immediate knowledge transmission, but also in continuously promoting learning to the transformation into work practice through real governance tasks.

3.2 Multi-Actor Collaborative Support and Feedback Regulation

To ensure the effective operation of live teaching, all actors and elements within the ecosystem must work together. Through division of labor and coordination, the teaching team can establish a complete closed loop of knowledge transfer and learning support. The lecturer provides professional knowledge and guides inquiry ; tutors organize learning activities and monitor the learning process ; learning center managers coordinate local activities, provide technical assistance, and implement support for learners ; industry practitioners or excellent learners contribute cases and practical experience. The collaboration between teaching and technology requires platform operators and technical support personnel to maintain close communication, so that technology deployment can accurately respond to teaching needs. The collaboration between formal learning and informal learning connects the live classroom with pre-class self-study and after-class peer discussion to form a complete learning chain. The effectiveness of this collaboration is ultimately reflected in the continuity of teaching and the stability of learners' continuous participation.

The ecosystem also contains a set of feedback regulation mechanisms. When the external environment changes, the feedback loop between the elements will promote the system to adjust itself, so as to maintain the normal operation. For example, when the platform data shows a decline in participation, teachers and learning centers can trace the reasons and adjust teaching, such as rescheduling teaching time, providing recording and broadcasting resources, or increasing counseling for key content. This forms a ' data collection-problem diagnosis-teaching adjustment-effect feedback ' cycle. For grassroots learners, a significant particularity is that their professional situations are difficult to be controlled by the system. Therefore, the system should be equipped with a fast response mechanism, flexible access methods and modular content, so that learners who miss the established class time can complete the supplementary study by watching the recorded video.

3.3 Development Pathways and Directions for Optimization

With the development of live-streaming platforms, learning analytics, and intelligent tools, more diverse interactions, data collection for learning, and personalized support have gained new conditions. However, their value ultimately depends on whether they can meet the learning needs of working adults and the requirements of grassroots governance. Therefore, optimization should emphasize the matching between technology, teaching methods, and the needs of learners, rather than regarding the complexity of technology itself as the goal to pursue.

Based on the above structure and operation mechanism, the optimization path can be carried out from five aspects. First, the contextualization of curriculum resources. Transform the content of the textbook into policy issues, governance cases and real work tasks, so that the learning content is closer to reality. Second, set up a compound teaching team. The team is composed of subject lecturers, tutors and front-line practitioners. Third, the teaching organization is more flexible. The mode of combining live teaching, recording and watching, modular learning and supplementary learning is adopted to alleviate the contradiction between learning and working of learners. Fourth, learning support runs through the whole process. It covers pre-class guidance, in-class interaction, after-class discussion, and application and feedback.

Fifth, quality evaluation should go beyond process indicators such as viewing frequency, duration, and completion rate, and focus on learners ' ability to analyze governance issues, the completion of practical tasks, and their migration and application in the workplace. That is to say, the focus of evaluation should shift from participation monitoring to ability formation and workplace application. These five directions jointly support the benign evolution of the ecosystem.

Conclusion and Prospects

From an ecological perspective, this study constructed and analyzed a live teaching ecosystem

aimed at cultivating grassroots governance personnel. The employment status, professional tasks, and learning needs of these learners determine that live teaching cannot merely focus on synchronous instruction but must develop into an ecosystem where actors, resources, technology, and environment work together. Its effective operation mainly relies on task-oriented governance, multi-agent collaboration, full-process support, and data-driven feedback regulation. The main contribution of this study lies in embedding the grassroots personnel training goals into the live teaching system of open education and incorporating the workplace experience of learners, the support of learning centers, and the governance context into the analytical framework. This framework provides a systematic basis for using live teaching to cultivate grassroots personnel such as village or community officials. However, this study is mainly based on theoretical analysis and practical experience refinement, and has not yet conducted cross-regional and cross-course comparative verification. Future research can utilize learning platform data, learner questionnaires, and comparative case studies to test the above mechanisms.

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