



Activity Theory as a Paradigm and Research Program for Veterinary, Animal, and Health-Sciences Education

Federico de la Colina Flores¹, Heriberto Rodríguez Frausto², Paul Alexis de la Colina García³, Tzitzí de la Colina García⁴

^{1,2} Universidad Autónoma de Zacatecas. México.

^{3,4} Colegio Edison A.C. Guadalupe, Zac. México.

ARTICLE INFO

Published Online:
03 August 2026

ABSTRACT

This article argues that activity theory can be treated, for education in veterinary medicine, animal science, and the health professions, as both a candidate Kuhnian paradigm and a Lakatosian research program. The argument is not that behaviorism, cognitivism, and constructivism were useless or simply false. Their durable contributions are preserved: behaviorism clarifies feedback, practice, and observable performance; cognitivism clarifies representation, reasoning, and problem solving; constructivism clarifies active meaning making and learner participation. Their limitation is that each takes a partial moment of learning as the center of the whole. Activity theory surpasses them by taking collective, object-oriented, culturally mediated activity as the unit of analysis. It therefore connects performance, cognition, identity, tools, rules, community, division of labor, and historical development within one explanatory framework. Enriched by Bedny's systemic-structural theory of activity, this paradigm becomes operational for curriculum design, simulation, clinical education, research training, and program evaluation. In veterinary and animal-science education, it reframes competencies as participation in activity systems such as diagnosis, herd-health consulting, surgery, nutrition planning, public health surveillance, and research translation. In health-professions education more broadly, it explains why authentic objects of work, mediating artifacts, distributed responsibility, and developmental trajectories are not optional methods but structural conditions for professional formation.

Corresponding Author:
Sofia Rodríguez Valenzuela

KEYWORDS: Activity theory; veterinary education; health-professions education; systemic-structural activity theory; educational paradigms; research programs; professional formation

I. INTRODUCTION

Educational debates often present behaviorism, cognitivism, and constructivism as successive paradigms. The simplified sequence is familiar. Behaviorism emphasizes observable behavior, reinforcement, practice, and environmental control. Cognitivism emphasizes mental representations, information processing, memory, reasoning, and problem solving. Constructivism emphasizes the active construction of meaning, prior knowledge, interaction, and learner agency. Each perspective corrected weaknesses in the previous one, and each remains visible in contemporary teaching. Drill, feedback, and performance standards are still behaviorist in spirit. Cognitive load, schemas, mental models, and diagnostic reasoning are cognitivist in spirit. Problem-based learning, inquiry, and collaborative knowledge construction are constructivist in spirit.

The difficulty is that the three traditions are usually treated as competing theories of learning rather than as partial views of a larger process. In professional education this is especially limiting. A veterinary student learning surgery is not merely displaying behavior, processing information, or constructing personal meaning. The student is entering a historically organized activity that includes a patient, instruments, anesthesia protocols, supervisors, ethical responsibilities, institutional rules, client expectations, risk, emotion, documentation, teamwork, and the possibility of harm. An animal-science student learning nutrition is not merely learning nutrient tables; the student is learning to transform feeding practices in farms, clinics, households, and communities under biological, economic, welfare, and ecological constraints. Health professional learning research is not merely applying methods; the researcher is participating in an activity system in which problems are

selected, data are produced, claims are justified, authorship is distributed, findings are published, and knowledge is used or ignored.

Activity theory offers a more powerful point of departure because it begins from the whole activity, not from an isolated response, mind, or subjective construction. In the cultural-historical tradition, human learning is formed in socially organized, object-oriented, mediated activity. The attached pedagogical article identifies six principles that define this orientation for educational design: unity of activity and consciousness, object orientation, the hierarchy of activity-action-operations, mediation, internalization/externalization, and development (Rodríguez Frausto et al., 2026c). Elsewhere, we apply those principles to veterinary and animal-science education through data analysis, surgery, and animal nutrition, showing that competencies can be designed as participation in authentic activity systems rather than as isolated skill lists (Rodríguez Frausto et al., 2026a). We also refine the action level by proposing central actions, such as production, persuasion or communication, distribution, and utilization, and peripheral actions, such as support, commitment, knowledge, visibility, access, and participation (Rodríguez Frausto et al., 2026b).

The present argument adds two philosophical tests. First, in Kuhn’s sense, a paradigm is not just a theory but a shared disciplinary matrix that defines exemplary problems, accepted methods, standards of adequacy, and normal research (Kuhn, 1970). Second, in Lakatos’s sense, a research program is a sequence of inquiry organized by a hard core, a protective belt of revisable auxiliary assumptions, and a heuristic that can become progressive when it predicts, explains, and generates new problems better than its rivals (Lakatos, 1970). Activity theory meets both tests more completely than the three educational paradigms it incorporates. It changes the unit of analysis, reorganizes the field of legitimate educational problems, and creates a coherent program for research and design in veterinary, animal, and health-sciences education.

II. METHODOLOGICAL ORIENTATION AND SOURCES

This article is a theoretical synthesis oriented toward educational design. It does not report an experiment and does not claim that activity-theoretical curricula are automatically superior in every empirical situation. Its purpose is more specific: to show that activity theory has the structural features required to function as a paradigm and as a research program for professional formation. The demonstration proceeds by examining explanatory scope, capacity to absorb older theories, practical generativity, and usefulness for research in professional domains.

The source base has three layers. The first layer is the activity-theoretical core: Vygotsky’s account of tool- and sign-mediated development, Leontiev’s theory of activity and the hierarchy of activity-action-operations, Engeström’s

expanded activity system and expansive learning, Roth and Lee’s review of cultural-historical activity theory in education, and Kaptelinin and Nardi’s synthesis of activity theory for human-technology interaction (Engeström, 2001, 2015; Kaptelinin & Nardi, 2006, 2012; Leontiev, 1978; Roth & Lee, 2007; Vygotsky, 1978). The second layer is our previous work, which translates these ideas into educational models, veterinary and animal-science examples, and a modified action typology (Rodríguez Frausto et al., 2026c, 2026a, 2026b). The third layer is Bedny’s systemic-structural theory of activity, which provides a more operational bridge between activity theory, work analysis, performance, training, and task design (G. Z. Bedny & Harris, 2005; G. Z. Bedny & Meister, 1999; G. Bedny & Karwowski, 2007).

This article also uses canonical sources for the paradigms being surpassed and subsumed. Behaviorism is represented through Watson and Skinner, cognitivism through Neisser and later cognitive science, and constructivism through Piaget and von Glasersfeld (Glasersfeld, 1989; Neisser, 1967; Piaget, 1970; Skinner, 1953; Watson, 1913). Health-professions and veterinary education sources are used to verify that the proposed paradigm speaks to existing concerns about competence, workplace learning, entrustment, professional identity, public health, and curriculum design (Association of American Veterinary Medical Colleges, 2018, 2024; Conn et al., 2021; Routh et al., 2022; Royal College of Veterinary Surgeons, 2023; Scholz et al., 2013; World Organisation for Animal Health, 2013).

A. What Counts as a Paradigm or Research Program in Education

A paradigm, in the strong sense, is not a fashionable vocabulary. It is a way of seeing and doing inquiry. It identifies the objects that matter, the questions that are worth asking, the procedures that count as legitimate, and the examples that train new members of a community. A paradigm also provides standards. It tells researchers and teachers what a good explanation looks like and what an adequate solution should accomplish. In physics, Kuhn’s own field of analysis, a paradigm organizes normal science. In education, a paradigm must organize normal pedagogical design and educational research. It must define what learning and development are, what should be observed, what should be changed, and how success should be judged.

On this standard, behaviorism, cognitivism, and constructivism have each functioned as educational paradigms. Behaviorism made learning visible as measurable change in behavior under environmental contingencies. Cognitivism made learning intelligible as information processing, representation, retrieval, and problem solving. Constructivism made learning meaningful as active construction rather than passive reception. Each paradigm trained teachers to see different phenomena. A behaviorist teacher sees reinforcement schedules, practice trials, prompts, and observable performance. A cognitivist teacher

sees schemas, prior knowledge, memory demands, misconceptions, and reasoning pathways. A constructivist teacher sees learners’ interpretations, dialogue, inquiry, and the restructuring of meaning.

A research program, in Lakatos’s sense, is evaluated differently. It is not judged by one isolated hypothesis. It is judged by whether its sequence of theories and methods becomes progressive. A progressive program does not merely defend itself from criticism; it produces new questions, designs, explanations, and empirical work. It can absorb anomalies that were troublesome for rival programs. It also guides future inquiry by telling researchers what to protect, what to modify, and where to look next.

Activity theory satisfies these conditions because it does more than add another teaching strategy. It redefines the central unit of educational analysis. Learning is not first a behavior, a mental representation, or an individual construction. Learning is the development of participation in object-oriented, culturally mediated activity. Behaviors, representations, and constructions are real, but they are moments within activity. Once the unit of analysis changes, the educational field is reorganized. The central question is no longer only “How do we reinforce the desired response?”, “How do we improve memory and reasoning?”, or “How do learners construct meaning?” The more comprehensive question becomes: “How is this learner, with others, using mediating tools to transform a meaningful object within a historically formed activity system, and how is the learner transformed in the process?”

This question can generate a new normal science for professional education. It directs attention to objects of practice, mediating artifacts, community, division of labor, rules or persuasive tools, contradictions, trajectories of participation, and utilization of outcomes. It also provides exemplary designs: the Change Laboratory for transforming work, the simulation pathway for gradually reorganizing surgical participation, the data-analysis studio oriented to herd health or One Health surveillance, the nutrition consultation as a negotiated activity with owners or producers, and the research group as a distributed activity system (Engeström, 2001; Rodríguez Frausto et al., 2026a, 2026b; Sannino et al., 2009).

B. The Three Paradigms and Their Unresolved Anomalies
Behaviorism was powerful because it forced education to take performance seriously. Watson argued for psychology as an objective science of behavior, and Skinner developed a systematic science of behavior shaped by consequences (Skinner, 1953; Watson, 1913). In education, this legacy remains valuable. Students need practice, feedback, discriminations, fluency, and observable standards. In veterinary surgery, for example, hand positioning, suture handling, knot security, aseptic routines, and response to instrument cues require repetition under controlled conditions. In data analysis, coding syntax, file organization,

and graph production also require routinized operations. A theory that ignores these matters is weak.

The anomaly is that behaviorism struggles when the educational object is not only performance but responsible participation in complex practice. A student can perform a suture pattern correctly yet fail to understand when it is indicated, how it affects tissue, how to communicate risk, or how to adapt under unexpected bleeding. A student can calculate a prevalence estimate but fail to understand the farm, community, or public-health problem that makes the estimate important. Behaviorism can shape operations but cannot, by itself, explain the motive, object, community, ethical responsibility, or historical development of the activity.

Cognitivism corrected the behaviorist restriction by reopening the black box. Neisser’s work helped define cognitive psychology as the study of processes such as perception, attention, memory, and thought (Neisser, 1967). In education, cognitivism explains why learners need conceptual organization, schemas, mental models, worked examples, memory supports, and metacognition. This is indispensable in veterinary diagnosis, statistical inference, pharmacology, pathology, epidemiology, and research design. A veterinary student must not only respond; the student must reason.

The anomaly is that cognitivism often treats cognition as if it were centered inside the individual and only secondarily applied in the world. In professional work, reasoning is distributed across people, artifacts, histories, and institutions. A diagnosis emerges through the patient, the owner, the record, the clinician, the laboratory, imaging technologies, clinical guidelines, economic constraints, and the student’s developing orientation to the case. A research result emerges through research questions, samples, instruments, code, statistical conventions, peer review, and publication genres. Cognition is not absent, but it is not enough to treat cognition as the independent center of the system.

Constructivism corrected the passivity implicit in some forms of instruction. Piaget’s genetic epistemology and later constructivist work emphasized that knowledge is actively constructed, not simply copied from the environment (Glaserfeld, 1989; Piaget, 1970). This insight supports active learning, inquiry, case discussion, reflective writing, and problem-based pedagogy. In animal and health sciences, students must reorganize prior beliefs, interpret evidence, and build meanings that are adequate to practice. Constructivism is therefore indispensable for avoiding empty memorization.

The anomaly is that constructivism can overemphasize individual or small-group meaning-making while underemphasizing material production, institutional organization, labor division, power, tools, and utilization. A nutrition plan is not successful because students constructed a coherent concept of nutrition. It is successful when it is usable by an owner or producer, biologically appropriate for

the animal, economically feasible, ethically defensible, and adjustable through follow-up. A research paper is not sufficient because it is meaningful to the authors. It must survive methodological scrutiny, persuade a community, and become available for use, critique, replication, or transformation. Constructivism clarifies meaning but needs a stronger account of object transformation in social practice.

The three traditions therefore leave a pattern of unresolved problems. Behaviorism sees performance but not the whole activity. Cognitivism sees reasoning but not its full social-material distribution. Constructivism sees meaning-making but not always production, utilization, and historical change. Activity theory does not discard their insights. It relocates them.

C. The Activity-Theoretical Unit of Analysis

The central move of activity theory is to take activity as the unit of analysis. For Vygotsky, higher psychological functions are mediated by cultural tools and signs and develop through social relations before becoming internal psychological functions (Vygotsky, 1978). For Leontiev, human consciousness cannot be understood apart from the object-oriented activities through which people live, work, and satisfy needs (Leontiev, 1978). For Engeström, the unit expands into an activity system, where subject, object, tools, community, rules, and division of labor form a historically developing whole (Engeström, 2001, 2015). Kaptelinin and Nardi synthesize this tradition through principles such as object orientation, mediation, hierarchical structure, internalization/externalization, and development (Kaptelinin & Nardi, 2006, 2012).

We add explicit emphasis to the unity of activity and consciousness and proposes six principles as a foundation for educational models (Rodríguez Frausto et al., 2026c). This is a decisive educational claim. Consciousness is not treated as an isolated mental container. It is formed through participation in activity. The future veterinarian's way of seeing an animal, a farm, a client, a dataset, or a research question develops through structured participation in forms of practice. The student's professional identity is not an attitude added to technical learning; it is formed through the motives, responsibilities, and objects of the activities in which the student participates.

Object orientation is equally important. An activity is not defined only by what people do visibly. It is defined by the object that gives the activity motive and direction. In professional education, the object must be more than a topic. “Mastitis” is a topic; reducing mastitis in a herd while balancing animal welfare, antimicrobial stewardship, economic feasibility, and producer participation is an object of activity. “Sutures” are a topic; closing tissue safely and responsibly in a surgical system that protects the animal is an object. “Statistics” is a topic; producing a trustworthy surveillance report that can guide action is an object.

The hierarchy of activity, actions, and operations clarifies why professional learning must be designed at several levels.

Activity is directed by motives. Actions are directed by conscious goals. Operations are adapted to concrete conditions and can become routinized. In surgical education, the activity may be safe veterinary care, the action may be performing a step in an ovariohysterectomy, and the operation may be a hand movement with a needle holder. In data analysis, the activity may be herd-health improvement, the action may be modeling risk factors, and the operation may be writing code. Professional formation fails when operations are trained without visible relation to actions and motives.

Mediation explains why tools are never neutral additions. Instruments, protocols, checklists, software, diagrams, case records, rubrics, consent forms, dashboards, and clinical guidelines shape what learners can perceive and do. Instrumental genesis extends this point by distinguishing artifacts from instruments: an artifact becomes an instrument when users develop schemes of use and transform the artifact in practice (Rabardel & Béguin, 2005; Vézillon & Rabardel, 1995). A Quarto template, a surgical simulator, or a nutrition handout does not automatically teach. It becomes educational through guided appropriation, redesign, critique, and use; this is why instrumented learning often requires deliberate orchestration rather than accidental exposure to tools (Trouche, 2004).

Internalization and externalization describe the movement between social-material action and internal psychological organization. Students first participate with external supports: protocols, diagrams, scripts, templates, models, peer talk, and instructor guidance. Over time, parts of that activity become internalized as professional perception, anticipation, judgment, and self-regulation. Externalization remains equally important because students must make their reasoning visible through reports, case presentations, dashboards, sketches, protocols, models, and publications. Learning is therefore not a one-way movement from outside to inside. It is a cycle in which thinking becomes action and action reorganizes thinking.

Development is the final principle. Activity systems have histories and contradictions. A contradiction is not merely a disagreement; it is a structural tension that can become a source of change. In veterinary education, contradictions appear when competency lists call for integrated practice while courses remain fragmented, when ethical commitments to animal welfare conflict with limited resources, when statistical training is required but taught without practice objects, or when simulation is treated as a technical drill rather than a path toward participation in clinical work. Activity theory makes these contradictions researchable and designable.

D. Adding Bedny's Systemic-Structural Perspective

Bedny's systemic-structural theory of activity strengthens the educational argument because it makes activity theory more operational for the analysis of work, performance, and training. Whereas many educational uses of activity theory

emphasize the triangular model and contradictions, Bedny’s approach insists on the structured, dynamic, and functional organization of activity. It is concerned with the relation between motives, goals, tasks, conditions, cognitive processes, self-regulation, action execution, and performance outcomes (G. Z. Bedny & Harris, 2005; G. Bedny & Karwowski, 2007).

This perspective is especially useful for veterinary, animal-science, and health-professions education because these fields require both broad social understanding and precise performance. A surgeon must participate in a clinical activity system, but the surgeon must also execute actions under time pressure, uncertainty, sensory-motor constraints, fatigue, and risk. A field epidemiologist must understand public-health systems, but must also handle sampling plans, case definitions, data quality, and analytic procedures. A nutrition consultant must understand production systems and owner behavior, but must also calculate, compare, document, and adjust feeding plans.

Bedny’s framework helps prevent a false opposition between the social and the technical. In a systemic-structural view, technical performance is not reduced to behaviorist skill, but neither is it dissolved into broad social theory. Performance can be analyzed by examining the task goal, object, means, conditions, methods, orientation, execution, control, and correction. This permits an educational designer to ask precise questions. What does the learner need to perceive? Which conditions change the action? Which operations should become automatic? Which steps must remain under conscious control? Which forms of feedback regulate the activity? Which errors show a lack of conceptual orientation rather than a lack of practice?

This matters for simulation. A low-cost suture model, a laparoscopic box trainer, a virtual patient, or a dataset is not simply an object for practice. It is a designed activity environment. Bedny’s perspective encourages educators to analyze the complexity of the task, the sequence of actions, the psychological demands, the feedback available, and the transfer conditions to real work (G. Z. Bedny & Meister, 1999; G. Bedny & Karwowski, 2007). It also matters for research training. A student writing a scientific article must learn not only “writing skills” but a structured activity: selecting a problem, building an argument, managing evidence, using software, coordinating coauthors, responding to reviewers, and placing knowledge into circulation.

The systemic-structural contribution also complements the modified action typology we proposed elsewhere. The typology distinguishes central actions that reproduce the object of activity from peripheral actions that stabilize and develop the system (Rodríguez Frausto et al., 2026b). Production directly transforms the object. Persuasion or communication secures legitimacy, shared understanding, and coordinated commitment. Distribution allocates responsibility, authority, resources, and sequencing. Utilization places outcomes into use and reveals their

adequacy. Support, commitment, knowledge, visibility, access, and participation ensure that the central cycle is not technically successful but socially unusable. This is a major contribution to professional education because programs often overdesign production and underdesign utilization, visibility, and participation.

E. How Activity Theory Subsumes Behaviorism

Activity theory subsumes behaviorism by placing observable performance within the operations and actions of an activity system. It does not deny that reinforcement, repetition, feedback, shaping, and environmental conditions matter. It explains where they matter and why they are insufficient as the whole theory of learning.

In professional education, many operations require behaviorist design. A student must learn to hold instruments correctly, identify microscope structures, follow biosafety procedures, produce clean datasets, enter commands, restrain animals safely, and comply with standard operating procedures. These operations benefit from repeated practice, immediate feedback, clear criteria, and progressive difficulty. A behaviorist approach is useful here because operations must become reliable under changing conditions.

However, activity theory prevents operational training from becoming empty drill. An operation has educational meaning only when it is nested in actions and activities. Suturing is not a free-standing behavior; it serves tissue repair, surgical safety, and animal welfare. Data cleaning is not a clerical behavior; it serves credible inference and responsible decision-making. Aseptic technique is not mere compliance; it serves patient safety, professional responsibility, and public trust.

In this sense, behaviorism becomes a local theory of operational stabilization. It is preserved as a theory of practice conditions and feedback at the level where it is strongest. It is surpassed because the educational object is no longer the behavior alone but the student’s developing participation in object-oriented activity. The question is not only whether the student performs correctly. It is whether the performance contributes to a meaningful professional object, under appropriate mediation, with ethical awareness and capacity for transfer.

This distinction is crucial for assessment. A checklist may evaluate operations, but professional assessment must also evaluate actions and activity-level participation. In a veterinary consultation, students must gather information, reason, communicate uncertainty, negotiate feasible plans, document decisions, and arrange follow-up. Observable behaviors matter, but their adequacy depends on the object of the consultation and on their relation to the community. Activity theory therefore preserves behaviorist accountability while rejecting behaviorist reduction.

F. How Activity Theory Subsumes Cognitivism

Activity theory subsumes cognitivism by placing mental representation, reasoning, memory, attention, and problem

solving within mediated activity. It does not deny cognition. It gives cognition a developmental, social, and material basis.

Professional education requires strong cognitive formation. Veterinarians, animal scientists, and health professionals need conceptual systems in anatomy, physiology, pathology, nutrition, epidemiology, pharmacology, statistics, research methods, and ethics. They need mental models that allow them to anticipate consequences, diagnose problems, interpret uncertainty, and make decisions. A purely behaviorist education cannot explain such reasoning.

Activity theory accepts this but changes the location of cognition. The student's reasoning is not an isolated computation inside the head. It is an orienting process in relation to an object, mediated by tools and shaped by the community. Bedny's systemic-structural theory is particularly useful here because it analyzes activity as including orientation, execution, control, and self-regulation (G. Z. Bedny & Harris, 2005; G. Bedny & Karwowski, 2007). A student reasoning through a case develops an orienting basis: what matters, what can be ignored, which signs are reliable, which actions are possible, which tools should be used, and when help is needed.

This transforms cognitive education. Teaching “clinical reasoning” cannot mean only presenting cases and asking for differential diagnoses. It must involve the progressive formation of an orienting basis in authentic activity. Students should learn how records, owner narratives, physical examination, laboratory data, imaging, guidelines, economic constraints, and welfare commitments mediate reasoning. They should also learn how to externalize reasoning in case notes, diagrams, reports, evidence summaries, and consultation explanations. Cognition becomes inspectable, discussable, and revisable.

In research training, the same principle applies. A graduate student learning statistics does not need only internal knowledge of methods. The student needs an activity system in which statistical reasoning is connected to research objects, data provenance, code, assumptions, reproducibility, reporting standards, peer review, and utilization. The attached veterinary education article gives a clear example in the herd-health data lab: operations such as coding and plotting are nested within actions such as modeling risk and within the broader activity of mastitis control (Rodríguez Frausto et al., 2026a). This is cognitivism absorbed into activity.

Activity theory therefore preserves cognitive depth while rejecting cognitive isolation. It explains why knowledge must be internalized, but also why knowledge must be externalized into artifacts that coordinate action. It explains why expert reasoning is often distributed across tools, records, software, teams, and histories. It also explains why mental models must be judged by their adequacy to object transformation, not merely by their internal coherence.

G. How Activity Theory Subsumes Constructivism

Activity theory subsumes constructivism by preserving active meaning-making while grounding it in socially consequential object-work. Learners do construct meanings, but they do so in activity systems with objects, technical and persuasive tools, communities, divisions of labor, rules, histories, and outcomes. Meaning is not the endpoint; transformed practice is.

Constructivism is valuable because students are not empty containers. They interpret, reorganize, and build understanding from prior experience. In veterinary education, students may arrive with folk beliefs about animals, disease, food production, pets, welfare, or scientific authority. In health-professions education, students must revise assumptions about patients, communities, risk, evidence, and professional identity. Active construction is therefore unavoidable.

Activity theory surpasses constructivism by asking what the construction is for and where it becomes consequential. A student's concept map of antimicrobial resistance is useful if it helps the student participate in surveillance, prescribing, client communication, and stewardship. A student's reflective essay about animal welfare is valuable if it reorganizes future perception and action in farms, clinics, laboratories, and communities. A team's co-constructed nutrition plan is educational if it is biologically sound, ethically defensible, economically feasible, understandable to the owner or producer, and adjustable through follow-up.

This is where our typology of central and peripheral actions becomes important. Constructivism tends to emphasize knowledge and participation. Activity theory adds production, persuasion, distribution, utilization, visibility, access, and commitment (Rodríguez Frausto et al., 2026b). These action families show that professional knowledge must become usable, legitimate, visible, and open to community participation. Knowledge that remains inside a classroom conversation has not completed the cycle of professional activity.

The same logic applies to social constructivist pedagogy. Collaboration is not automatically educational. A group may talk actively and still avoid the object. Activity theory requires educators to design the object, roles, tools, accountability, and forms of utilization. It asks whether collaboration improves the transformation of the object and the development of participants. This produces a stricter and more professional form of constructivism: active meaning-making is necessary, but it must be accountable to the object, the community, and the consequences of action.

H. Activity Theory as a Kuhnian Educational Paradigm

Activity theory can function as a Kuhnian educational paradigm because it provides a new disciplinary matrix for educational work. Its symbolic generalization is that learning and development occur in object-oriented, mediated activity. Its model of the learner is not a passive respondent, an isolated processor, or a self-contained

constructor, but a participant in collective practices. Its values include social object adequacy, developmental transformation, mediation, historical analysis, participation, responsibility, and expansive change. Its exemplars include activity-system analysis, developmental work research, Change Laboratories, simulation pathways, object-oriented studios, and workplace formation interventions (Conn et al., 2021; Engeström, 2001; Rodríguez Frausto et al., 2026a; Sannino et al., 2009).

A Kuhnian paradigm also changes what counts as a good research problem. Under behaviorism, a good problem may be the control of responses through reinforcement. Under cognitivism, it may be the optimization of mental processing. Under constructivism, it may be the improvement of meaning-making. Under activity theory, objects come from social needs in relation to modes of life, thus, a good problem is the transformation of an activity system. Why do students fail to transfer statistics to clinical or herd-health decisions? The answer may not lie only in motivation or cognition. It may lie in a curriculum where statistics is taught without objects of veterinary practice, where software is used as a ritual artifact, where assessment rewards decontextualized calculation, and where no community uses the student-produced analysis. Activity theory makes this whole configuration visible.

The paradigm also changes design standards. A course is not judged only by content coverage, student satisfaction, or test scores. It is judged by whether students gain increasingly responsible participation in meaningful activity. A data-analysis course should produce students who can use data to act in animal and public-health systems. A surgery course should produce students who can participate safely in surgical care under supervision and progressively assume responsibility. A nutrition course should produce students who can negotiate feasible feeding plans with owners or producers. A research course should produce students who can transform a problem into a credible, documented, communicated, and usable contribution.

The paradigm also changes the role of the teacher. The teacher is not only a reinforcer, explainer, or facilitator. The teacher is an organizer of activity systems. This includes selecting objects, designing tools, arranging communities, distributing roles, making criteria explicit, supporting instrumental genesis, managing contradictions, and guiding cycles of internalization and externalization. The teacher remains a subject-matter expert, but expertise is exercised through the design of collective activity.

The paradigm changes the role of assessment. Assessment is not simply measurement of individual knowledge or behavior. It becomes analysis of development across levels. At the operational level, educators assess fluency, safety, accuracy, and reliability. At the action level, they assess goal-directed performance such as diagnosis, analysis, consultation, intervention, and documentation. At the activity level, they assess participation in the

transformation of meaningful objects and the capacity to reflect on consequences. This aligns with competency-based veterinary education and entrustable professional activities, but it gives them a stronger theory of how integrated work is incorporated (Association of American Veterinary Medical Colleges, 2018, 2024; Cate et al., 2015).

Finally, activity theory changes the image of educational research. Instead of treating classrooms as places where variables are applied to individuals, it treats educational settings as activity systems with histories. Research can still use quantitative outcomes, but it must also study artifacts, contradictions, roles, discourse, utilization, and development. The aim is not only to know whether an intervention works, but to understand how and why a system changes.

I. Activity Theory as a Lakatosian Research Program

Activity theory can also function as a Lakatosian research program. Its hard core is the claim that human consciousness, learning, and competence develop through participation in socially organized, object-oriented, mediated activity. This hard core should not be abandoned whenever one intervention fails. A failed implementation may indicate problems in the protective belt: the chosen object was artificial, the tools were poorly designed, the division of labor remained teacher-centered, the assessment contradicted the motive, the community did not use the products, or the developmental trajectory was too short.

The negative heuristic is clear. Do not reduce learning to isolated behavior, isolated cognition, isolated construction of meaning, isolated individual competence, or isolated classroom events. Do not treat tools as neutral. Do not treat professional competence as a list detached from the systems in which competence is used. Do not treat contradictions as implementation noise. Do not treat outcomes as complete until they are applied.

The positive heuristic is equally clear. Identify the activity system. Clarify the object. Analyze the subject, tools, community, rules or persuasive tools, and division of labor. Distinguish activity, actions, and operations. Examine mediation and instrumental genesis. Design externalizations such as reports, protocols, dashboards, case presentations, and publications. Follow development over time. Look for contradictions and redesign the system. Study whether the object is transformed and whether participants develop new agency.

This research program becomes progressive when it generates new educational designs and explains failures that older paradigms misread. Suppose students perform well in a statistics exam but cannot use data in clinical research. Behaviorism may recommend more practice, cognitivism may recommend better explanations, and constructivism may recommend more active learning. Activity theory asks whether statistics has been connected to objects of veterinary practice that come out of actual needs, whether data artifacts are authentic, whether analysis is used by a community, whether students externalize findings in genres that matter,

and whether later courses require the same tools at higher levels of responsibility. This wider explanation leads to more powerful redesign.

Suppose students succeed on surgical simulators but struggle in live surgery. A narrow explanation may blame anxiety, lack of practice, or low fidelity. Activity theory examines the developmental trajectory from simulator to tissue lab to supervised clinical activity. It asks whether the simulator trains the operations that matter, whether students understand the surgical object, whether team communication is practiced, whether supervisors distribute responsibility progressively, whether reflection externalizes tacit judgment, and whether follow-up reveals consequences. Bedny's systemic-structural approach adds more precise analysis of task complexity, orientation, feedback, and conditions (G. Bedny & Karwowski, 2007).

Suppose a research methods course produces acceptable protocols but few usable studies. Activity theory asks whether research is taught as a school task or as participation in a research activity system. It examines the object, community, methods, data infrastructure, authorship, ethical review, publication genres, and knowledge translation. Our typology adds a decisive point: production of data or manuscripts is incomplete without persuasion, distribution, utilization, visibility, access, and participation (Rodríguez Frausto et al., 2026b). This is a more progressive diagnosis than blaming students' motivation or writing ability.

The Lakatosian strength of activity theory is that it guides future inquiry. It does not merely criticize older paradigms. It proposes researchable hypotheses: authentic objects should improve transfer when linked to genuine utilization; mediating artifacts should become more powerful when students appropriate and redesign them; contradictions between assessment and motive should reduce development; longitudinal revisiting of the same professional object should support deeper participation; role distribution should affect agency and entrustment; visibility of student products should influence accountability and identity formation. These are not slogans. They can be studied.

J. Application to Veterinary and Animal-Science Education

Veterinary and animal-science education is an ideal domain for activity theory because it deals with living systems, professional responsibility, technical performance, uncertainty, social trust, and material consequences. International and professional frameworks already emphasize competence, public responsibilities, Day One competencies, and longitudinal development (Association of American Veterinary Medical Colleges, 2024; Royal College of Veterinary Surgeons, 2023; World Organisation for Animal Health, 2013). Activity theory does not replace these frameworks. It gives them a deeper pedagogical structure.

In data analysis, the object should not be “learn regression” or “make graphs.” The object should be a

veterinary or animal-science problem that requires data in order to be transformed. A mastitis surveillance report, an antimicrobial-use dashboard, a welfare audit, a reproductive-performance analysis, a feed-efficiency study, or a One Health surveillance brief gives statistical learning a professional motive. Operations such as coding, cleaning, plotting, and modeling are then nested in actions such as describing a herd problem, testing associations, estimating uncertainty, and communicating recommendations. We have already developed this logic through herd-health and One Health examples (Rodríguez Frausto et al., 2026a).

In surgery, the object is not manual skill alone. The object is safe surgical care for the animal within a team and institutional system. A progressive pathway should begin with operations on models, move through tissue labs and structured simulation, and then enter supervised clinical participation. This pathway is not only a sequence of increasing fidelity. It is a developmental reorganization of the activity system. The student's role, tools, feedback, responsibility, emotional regulation, and relation to the animal change across stages. Assessment must therefore include technical performance, preparation, communication, judgment, documentation, and response to complications.

In animal nutrition, the object is not calculation alone. It is a feasible nutritional plan for an animal, herd, or production system. Students must learn nutrient requirements, ingredient composition, ration formulation, body condition scoring, disease interactions, and economic constraints. But activity theory insists that these cognitive and technical components be placed in a wider system. Owners, producers, feed suppliers, veterinarians, animal welfare standards, environmental pressures, and local resources mediate the activity. A correct ration that is not adopted is not yet a successful professional outcome. Utilization is part of the activity.

In public health and One Health, activity theory is even more necessary. Zoonotic disease control, antimicrobial resistance, food safety, and environmental health cannot be understood as individual knowledge problems. They require coordination among veterinarians, physicians, animal scientists, producers, laboratories, communities, public agencies, and policy-makers. Participatory epidemiology shows why local knowledge and community participation matter in animal-health fieldwork (Catley et al., 2012). One Welfare approaches similarly show that human welfare, animal welfare, and environmental conditions are intertwined (García Pinillos et al., 2016). Activity theory supplies the educational structure needed to train professionals who can participate in such systems.

K. Application to Health-Professions Education

Health-professions education has increasingly recognized that competence is not reducible to classroom knowledge. Clinical education, workplace learning, interprofessional collaboration, simulation, patient safety, and quality improvement require systemic analysis. Activity theory has

already been used in health-professions education to study complex learning and intervention, not merely to describe individual acquisition (Conn et al., 2021; Engeström & Pyörälä, 2021).

The activity-theoretical paradigm is useful across health fields because clinical work is inherently mediated and distributed. A diagnosis is made through patient narratives, bodily signs, instruments, records, team communication, guidelines, institutional pressures, and professional judgment. A treatment plan is negotiated among professionals, patients, families, technologies, costs, risk, and follow-up. A public-health intervention depends on data systems, policy tools, community trust, and implementation structures.

This means health-professions curricula should be designed around core activity systems rather than only disciplines. Examples include clinical consultation, emergency response, chronic disease management, infection control, community surveillance, rehabilitation planning, health education, and research translation. Disciplines remain indispensable, but they become tools for object transformation. Physiology, pathology, epidemiology, pharmacology, communication, ethics, and statistics are learned because they make participation possible.

Simulation should also be redesigned. A simulation is not only a technique for practicing skills. It is a deliberately simplified activity system. Its educational value depends on whether the object is clear, the tools are appropriate, the roles are meaningful, feedback is aligned, and debriefing externalizes reasoning and emotion. Bedny’s systemic-structural approach supports this by analyzing task structure, performance demands, and self-regulation. Activity theory adds the wider social and developmental structure.

Interprofessional education benefits from the same logic. Collaboration cannot be taught only by placing different professions in the same room. The activity must have a shared object. The division of labor must be explicit. The mediating artifacts must support coordination. Contradictions among professional values, rules, and responsibilities must be made discussable. Students must produce something that the community can inspect and use. Without a shared object and utilization, interprofessional learning risks becoming ceremonial.

L. Application to Researcher Formation

Researchers in veterinary, animal, and health sciences are often trained through methods courses, thesis supervision, laboratory practice, and publication pressure. Activity theory suggests that these elements should be reorganized as participation in research activity systems.

The object of research training is not “knowing methodology.” It is the capacity to transform a scientific or professional problem into credible, ethical, communicable, and usable knowledge. This object requires technical tools such as laboratory methods, field protocols, software, statistical models, qualitative methods, reference managers,

and writing platforms. It also requires persuasive tools such as arguments, abstracts, figures, ethical protocols, preregistrations, grant proposals, reviewer responses, and public communication. Our action typology is especially valuable here because research fails when production is separated from persuasion, visibility, distribution, and utilization (Rodríguez Frausto et al., 2026b).

A doctoral student learning research should therefore move through a developmental trajectory. Early work may involve reproducing analyses, reading papers, preparing annotated bibliographies, and writing structured summaries. Intermediate work may involve designing small studies, cleaning datasets, creating figures, defending methodological choices, and presenting preliminary findings. Advanced work should involve leading a study, negotiating roles, managing ethical responsibilities, writing manuscripts, responding to critique, and planning knowledge translation. This is not only cognitive apprenticeship; it is progressive participation in the full activity system of research.

Activity theory also clarifies research ethics. Ethics is not a rule external to research. It is mediated commitment to human participants, animals, communities, data integrity, and future users of knowledge. Consent documents, animal-use protocols, data-management plans, welfare standards, authorship agreements, and community reports are not bureaucratic obstacles. They are mediating artifacts that shape the moral structure of the activity. This is why we propose replacing the abstract rules node with a persuasion tool that carries justification, legitimacy, and commitment through designed artifacts (Rodríguez Frausto et al., 2026b).

Knowledge translation completes the cycle. Producing a paper is not the end of research activity. Findings enter utilization when clinicians, producers, public agencies, laboratories, teachers, or communities adopt, adapt, reject, or critique them. Knowledge-to-action frameworks emphasize that implementation requires adaptation, monitoring, evaluation, and feedback rather than mere dissemination (Graham et al., 2006; Thomas & Bussi eres, 2016). Activity theory gives this point a deeper foundation: utilization is a central action in the reproduction and development of the object.

M. Curriculum Design Under the Activity-Theoretical Paradigm

An activity-theoretical curriculum begins from objects of practice. In veterinary and animal sciences, these objects may include animal health, herd productivity, welfare, food safety, public health, sustainable production, clinical care, research problems, and community development. In health professions, they may include patient care, prevention, rehabilitation, chronic disease management, emergency response, public communication, and quality improvement. Curriculum designers should identify the activity systems in which graduates must participate and then work backward to the knowledge, tools, roles, and operations that make participation possible.

This reverses the usual disciplinary sequence. Instead of asking which topics belong in which course, the designer asks which activity objects should organize the program. Disciplines then become mediating resources. Anatomy serves diagnosis and surgery. Physiology serves clinical reasoning and production management. Statistics serves research, surveillance, and decision-making. Communication serves persuasion, trust, and shared decision-making. Ethics serves commitment and responsible action. This does not weaken disciplinary rigor. It gives rigor a functional place.

The curriculum should spiral around recurrent objects. Early students may engage simplified versions of an object with strong scaffolding. Later students revisit the object under more complex conditions, less support, and greater responsibility. For example, antimicrobial resistance can appear first as a conceptual case, then as a data-analysis studio, then as a farm or clinic stewardship project, then as a research or policy brief. Surgery can move from instruments to models, tissue labs, supervised procedures, complication analysis, and quality improvement. Nutrition can move from nutrient concepts to case calculations, owner communication, herd consultancy, and follow-up evaluation.

The division of labor must be intentionally designed. Students should not remain passive recipients of teacher explanation. They should gradually assume roles such as data manager, case presenter, instrument handler, surgical assistant, client educator, welfare auditor, literature reviewer, data analyst, protocol designer, and community liaison. These roles are not decorations. They are pathways into professional agency. Teachers, clinicians, technicians, producers, owners, patients, researchers, all armed with conceptual, material, and digital tools, participate in the activity system, and their roles must be visible.

Assessment should be multimodal and developmental. It should include direct observation of operations, evaluation of goal-directed actions, review of produced artifacts, reflection on reasoning and identity, community feedback, and evidence of utilization. Rubrics should not only ask whether the student knows the content. They should ask whether the student can use tools responsibly, coordinate with others, justify decisions, adapt to conditions, and improve the object of activity. Competency-based frameworks and EPAs provide useful language for entrustment, but activity theory supplies the architecture that connects competencies to objects, tools, communities, and development (Association of American Veterinary Medical Colleges, 2018, 2024; Cate et al., 2015).

N. Research Questions Generated by the Program

A progressive research program should generate questions that older paradigms do not formulate well. Activity theory does this. In veterinary data education, researchers can ask whether object-oriented data studios improve transfer to clinical and herd-health decision-making more than traditional statistics courses. They can examine which mediating artifacts, such as templates, dashboards, code

notebooks, or policy briefs, best support internalization and externalization. They can test whether student-produced artifacts are actually used by communities and whether utilization affects motivation and identity.

In surgical education, researchers can ask how task structure, simulator design, team roles, and reflection affect movement from operations to actions and activity-level participation. They can use Bedny's systemic-structural theory to analyze cognitive-motor demands and activity theory to study the social system of supervision, entrustment, and responsibility. They can investigate contradictions between simulation assessment and clinical practice, and redesign pathways accordingly.

In animal nutrition, researchers can study how owner or producer participation changes student learning and plan adoption. They can compare school-internal ration exercises with consultation-based projects in which students must produce usable recommendations. They can analyze failures of utilization to identify whether the problem lies in knowledge, communication, economics, access, welfare conflict, or institutional support.

In health-professions education, researchers can examine interprofessional learning as shared object transformation rather than attitude change alone. They can study how digital agents, electronic records, simulation platforms, and decision-support systems redistribute cognition and responsibility. Activity theory is well suited to technology-rich learning and development because it treats tools as mediators that reorganize action rather than as neutral delivery devices (Kaptelinin & Nardi, 2006, 2012).

In researcher formation, researchers can ask how students become capable of producing, defending, publishing, and translating knowledge. They can study the development of scientific writing as participation in persuasive genres. They can analyze research groups through central and peripheral actions. They can examine how authorship, access to data, mentorship, software, peer review, and community participation affect scientific agency. These questions show the program's generativity.

O. Limits, Risks, and Critical Tests

The strongest version of the argument should not claim that activity theory solves every educational problem by vocabulary alone. A paradigm can degenerate into rhetoric if its terms are repeated without empirical discipline. Activity systems, objects, mediation, contradictions, and development must be used analytically, not decoratively. A diagram is not an analysis. A project is not automatically an activity-theoretical design. A simulation is not automatically developmental. A community partnership is not automatically participatory.

There is also a risk of excessive breadth. Because activity theory can include almost everything, weak applications may fail to identify the most important relations. Bedny's systemic-structural perspective helps control this risk by requiring more precise analysis of tasks, goals, conditions,

orientation, execution, control, and performance (G. Z. Bedny & Harris, 2005; G. Bedny & Karwowski, 2007). Our action typology also helps because it gives educators a tractable middle layer between broad activity systems and low-level operations (Rodríguez Frausto et al., 2026b).

The paradigm also requires empirical testing. Activity-theoretical designs should be evaluated through mixed evidence: student performance, quality of artifacts, transfer to workplace tasks, development of professional identity, community use, patient or animal outcomes where appropriate, and longitudinal trajectories. It should be possible to show when an activity-theoretical intervention fails and why. The theory should not protect itself by calling every failure a misapplication. Instead, failures should refine the protective belt and improve the program.

A further test is ethical. Activity theory emphasizes object transformation, but professional education must ask who defines the object. In veterinary and health fields, objects involve animals, patients, producers, owners, communities, institutions, ecosystems, and future users of knowledge. An activity system can reproduce harmful practices if its object is poorly chosen or if participation is restricted. Therefore, activity-theoretical education must include critical reflection on welfare, justice, sustainability, access, and power. The One Health and One Welfare orientations are not external additions; they are part of defining worthy objects of activity (García Pinillos et al., 2016; World Organisation for Animal Health, 2013).

These limits do not weaken the claim that activity theory offers a stronger paradigm. They clarify the conditions under which the claim should be accepted. A progressive educational research program must be able to generate designs, expose contradictions, preserve useful insights from older paradigms, and remain open to correction. Activity theory can do this.

III. CONCLUSION

Activity theory offers a new educational paradigm for veterinary, animal-science, and health-professions education because it reorganizes the central question of learning. Learning is not merely behavior change, information processing, or personal construction of meaning. It is the development of participation in collective, object-oriented, mediated activity. This single shift allows the theory to surpass and subsume behaviorism, cognitivism, and constructivism. Their strongest insights are preserved as partial moments: operations and feedback, cognition and orientation, meaning-making and participation. Their weakness is overcome by placing those moments inside activity systems with objects, tools, communities, divisions of labor, persuasive or normative artifacts, histories, contradictions, and utilization.

As a Kuhnian paradigm, activity theory supplies a disciplinary matrix for educational design and research. It defines a unit of analysis, standards of explanation,

exemplary problems, and model designs. As a Lakatosian research program, it has a hard core, a negative heuristic against reductionism, and a positive heuristic for analyzing and transforming educational activity systems. It becomes progressive when it explains failures of transfer, competence, simulation, research training, and professional identity better than older paradigms, and when it generates testable designs.

Bedny's systemic-structural theory of activity strengthens the proposal by making activity analysis more precise for performance, task structure, work design, and training. We have extended the proposal into educational models, veterinary and animal-science domains, and a typology of central and peripheral actions. Together, these sources support a coherent conclusion: activity theory should not be treated only as one more educational lens. It can organize a new research program and a new paradigm for forming professionals and researchers capable of transforming the systems in which animal, human, and environmental health are produced.

REFERENCES

1. Association of American Veterinary Medical Colleges. (2018). Competency-based veterinary education: Entrustable professional activities. <https://www.aavmc.org/wp-content/uploads/2020/10/CBVE-Publication-2-EPA.pdf>
2. Association of American Veterinary Medical Colleges. (2024). Competency-based veterinary education: CBVE 2.0. https://www.aavmc.org/wp-content/uploads/2024/04/AAVMC-CBVE-2.0_Final.pdf
3. Bedny, G. Z., & Harris, S. R. (2005). The systemic-structural theory of activity: Applications to the study of human work. *Mind, Culture, and Activity*, 12(2), 128–147. https://doi.org/10.1207/s15327884mca1202_4
4. Bedny, G. Z., & Meister, D. (1999). Theory of activity and situation awareness. *International Journal of Cognitive Ergonomics*, 3(1), 63–72. https://doi.org/10.1207/s15327566ijce0301_5
5. Bedny, G., & Karwowski, W. (2007). A systemic-structural theory of activity: Applications to human performance and work design. CRC Press. <https://doi.org/10.1201/9781420009743>
6. Cate, O. ten, Chen, H. C., Hoff, R. G., Peters, H., Bok, H., & Schaaf, M. van der. (2015). Curriculum development for the workplace using entrustable professional activities (EPAs): AMEE guide no. 99. *Medical Teacher*, 37(11), 983–1002. <https://doi.org/10.3109/0142159X.2015.1060308>
7. Conn, R. L., Gormley, G. J., O'Hare, S., & Kajamaa, A. (2021). Activity theory in health professions education research and practice. In D. Nestel, G. Reedy, L. McKenna, & S. Gough (Eds.), *Clinical education for the health professions*:

- Theory and practice. Springer. https://doi.org/10.1007/978-981-13-6106-7_30-1
8. Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133–156. <https://doi.org/10.1080/13639080020028747>
9. Engeström, Y. (2015). *Learning by expanding: An activity-theoretical approach to developmental research* (2nd ed.). Cambridge University Press.
10. Engeström, Y., & Pyörälä, E. (2021). Using activity theory to transform medical work and learning. *Medical Teacher*, 43(1), 7–13. <https://doi.org/10.1080/0142159X.2020.1795105>
11. García Pinillos, R., Appleby, M. C., Manteca, X., & Scott-Park, F. (2016). One welfare: A platform for improving human and animal welfare. *Veterinary Record*, 179(16), 412. <https://doi.org/10.1136/vr.i5470>
12. Glasersfeld, E. von. (1989). Cognition, construction of knowledge, and teaching. *Synthese*, 80(1), 121–140. <https://doi.org/10.1007/BF00869951>
13. Graham, I. D., Logan, J., Harrison, M. B., Straus, S. E., Tetroe, J., Caswell, W., & Robinson, N. (2006). Lost in knowledge translation: Time for a map? *Journal of Continuing Education in the Health Professions*, 26(1), 13–24. <https://doi.org/10.1002/chp.47>
14. Kaptelinin, V., & Nardi, B. A. (2006). *Acting with technology: Activity theory and interaction design*. MIT Press.
15. Kaptelinin, V., & Nardi, B. A. (2012). *Activity theory in HCI: Fundamentals and reflections*. Morgan & Claypool. <https://doi.org/10.2200/S00413ED1V01Y201203HCI013>
16. Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). University of Chicago Press.
17. Lakatos, I. (1970). Falsification and the methodology of scientific research programmes. In I. Lakatos & A. Musgrave (Eds.), *Criticism and the growth of knowledge* (pp. 91–196). Cambridge University Press.
18. Leontiev, A. N. (1978). *Activity, consciousness, and personality* (M. J. Hall, Trans.). Prentice-Hall.
19. Neisser, U. (1967). *Cognitive psychology*. Appleton-Century-Crofts.
20. Piaget, J. (1970). *Genetic epistemology* (E. Duckworth, Trans.). Columbia University Press. <https://doi.org/10.7312/piag91272>
21. Rabardel, P., & Béguin, P. (2005). Instrument mediated activity: From subject development to anthropocentric design. *Theoretical Issues in Ergonomics Science*, 6(5), 429–461. <https://doi.org/10.1080/14639220500078179>
22. Rodríguez Frausto, H., Colina Flores, F. de la, Colina García, T. de la, & Colina García, P. A. de la. (2026a). Activity theory in veterinary and animal science education: Examples in data analysis, surgery, and animal nutrition. *International Journal of Innovative Research in Multidisciplinary Education*, 5(3), 249–257. <https://doi.org/10.58806/ijirme.2026.v5i3n09>
23. Rodríguez Frausto, H., Colina Flores, F. de la, Colina García, T. de la, & Colina García, P. A. de la. (2026b). Central and peripheral actions in a modified activity system: A typology for veterinary, animal-husbandry, and health-sciences education and research. *International Journal of Current Research in Multidisciplinary*, 11(2), 8–20.
24. Rodríguez Frausto, H., Colina Flores, F. de la, Colina García, T. de la, & Colina García, P. de la. (2026c). Activity theory as a pedagogical foundation for educational models. *International Journal of Scientific Research and Modern Technology*, 5(1), 72–78. <https://doi.org/10.38124/ijrmt.v5i1.1139>
25. Roth, W.-M., & Lee, Y.-J. (2007). Vygotsky’s neglected legacy: Cultural-historical activity theory. *Review of Educational Research*, 77(2), 186–232. <https://doi.org/10.3102/0034654306298273>
26. Routh, J., Paramasivam, S. J., Cockcroft, P., Nadarajah, V. D., & Jeevaratnam, K. (2022). Using learning theories to develop a veterinary student preparedness toolkit for workplace clinical training. *Frontiers in Veterinary Science*, 9, 833034. <https://doi.org/10.3389/fvets.2022.833034>
27. 28. Royal College of Veterinary Surgeons. (2023). Day one competences. <https://www.rcvs.org.uk/news-and-views/publications/rcvs-day-one-competences/>
28. 29. Sannino, A., Daniels, H., & Gutiérrez, K. D. (Eds.). (2009). *Learning and expanding with activity theory*. Cambridge University Press.
29. 30. Scholz, E., Trede, F., & Raidal, S. L. (2013). Workplace learning in veterinary education: A sociocultural perspective. *Journal of Veterinary Medical Education*, 40(4), 355–362. <https://doi.org/10.3138/jvme.0113-015R>
30. 31. Skinner, B. F. (1953). *Science and human behavior*. Macmillan.
31. 32. Thomas, A., & Bussiès, J.-F. (2016). Knowledge translation and implementation science in health professions education: Time for clarity. *Academic Medicine*, 91(12), e20–e25. <https://doi.org/10.1097/ACM.0000000000001396>