

# The Dualism of Interdisciplinarity: A Model for Agriculture, Food, and Natural Resources Education

## Abstract

*Interdisciplinary in an increasingly popular term in educational settings. Analysis of the term reveals two meanings, a characteristic of an individual (i.e., interdisciplinary thinking) and a characteristic of a group (i.e., interdisciplinary collaborations). This paper serves to delineate those two meanings while building a conceptual model of the relationship between interdisciplinary thinking and collaboration wherein the two are mutually reinforcing educational experiences. In addition to modeling the two interdisciplinary outcomes, transitional processes are described. The first transitional process, transfer of interdisciplinarity, encourages learner transition from interdisciplinary thinking to participating in interdisciplinary collaborations, including a focus on working in teams, appreciation for diversity, understanding the problem or phenomenon, and awareness of individual expertise. The second transitional process, experiential interdisciplinarity, attends to the individual knowledge constructed from interdisciplinary collaborations and includes learning through reflection, managing cognitive disequilibrium, and operationalizing diverse ideas. The resultant model provides a cyclical process for engaging learners in building interdisciplinary thinking and interdisciplinary collaboration skills. Recommendations are made for the application of the model in research and educational efforts to increase the interdisciplinarity of agriculture, food, and natural resources education.*

**Keywords:** collaboration; diversity; experiential learning; interdisciplinary; teams; transfer

## Introduction

The term “interdisciplinary” has become increasingly associated with high quality education (Boix Mansilla et al., 2006). Defined as experiences which combine multiple disciplines to form an understanding of a phenomenon, or to solve a problem, interdisciplinary education represents a shift in traditional, disciplinary approaches (Boix Mansilla et al., 2000; Nikitina, 2006). The context of agriculture, food, and natural resources (AFNR) is inherently interdisciplinary (McKim et al., 2017a).

Within AFNR learning opportunities (e.g., secondary school classrooms, community workshops), the convergence of science, mathematics, social studies, ethics, English language arts, engineering, and other disciplines is expected to develop learner understanding of complex natural systems (Scherer et al., 2019). This strong interdisciplinary focus, however, has not always been true within AFNR Education. Research suggests the discipline has gone through three distinct phases defined by vacillating emphasis on interdisciplinarity (McKim et al., 2017a). In the first phase, prior to the Smith-Hughes Act of 1917, AFNR Education was defined by the dissemination of science knowledge developed at experiment stations; thus, the discipline was focused on interdisciplinary education (McKim et al., 2017a). The second phase (i.e., 1917-1988), however, represented a notable lack of interdisciplinary focus due to established boundaries between academic and vocational content and academic tracking (McKim et al., 2017a). The third and current phase, starting in 1988, is marked by a reconvergence of core academic areas and AFNR content to increase the sustainability of the discipline amongst heightened core academic graduation requirements (McKim et al., 2017a).

The return to interdisciplinarity within AFNR Education seizes the benefits of these types of learning environments, as elucidated within the literature. Research in interdisciplinarity suggests educational spaces which combine content from multiple disciplines better prepare learners to sustainably address complex problems like climate change, deforestation, hunger, and water scarcity (Borrego & Newswander, 2010; Jacob, 2015; Klein, 2008). Therefore, preparing learners to think in an interdisciplinary way is critical to giving current and future generations the best chance to address these wicked problems (Newell, 2010).

The concept “interdisciplinary,” however, is not reserved for learning experiences which meld multiple disciplines (Huutoniemi et al., 2010). Interdisciplinary also refers to collaborations among individuals representing multiple disciplines (e.g., communications, animal sciences, economics, and engineering represented among team members collaborating to develop and disseminate a new technology). Funding opportunities and research featuring interdisciplinary collaborations have grown in tandem with awareness that interdisciplinary teams are essential to addressing problems which transcend traditional disciplinary boundaries (Bossio et al., 2013; Klein, 2008; Petri, 2010). Therefore, in addition to the need for interdisciplinary thinking, interdisciplinary collaborations are essential to solving complex and wicked problems.

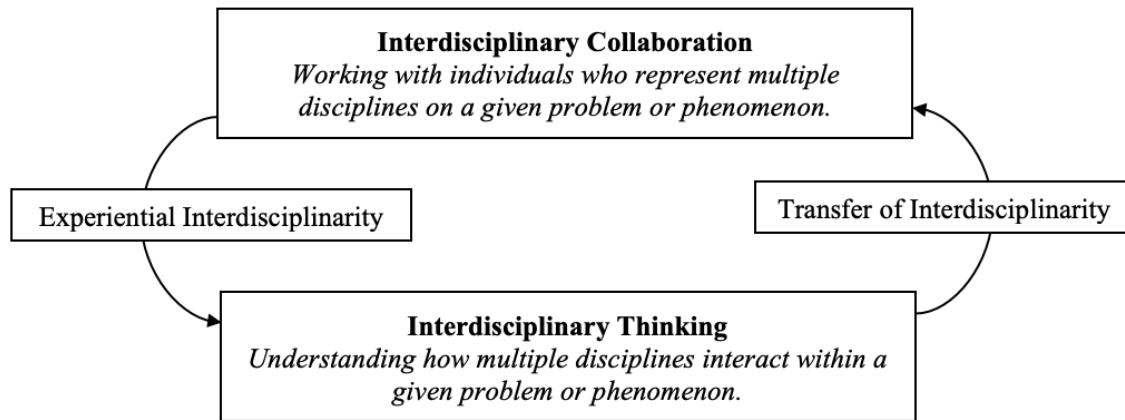
The dual use of “interdisciplinary” to represent both thinking and collaboration presents challenges and opportunities. As examples, a potential for ambiguity exists regarding the term interdisciplinary, but an opportunity for increased support exists for interdisciplinary work. In this theoretical manuscript, interdisciplinary thinking and interdisciplinary collaboration are delineated and their relationship modeled. By modeling the relationship, interactions between the two concepts are explored and practical strategies uncovered to develop both interdisciplinary thinking and collaboration among learners in AFNR contexts.

### **Purpose**

Acknowledging the need to bring together concepts related to interdisciplinarity, the current theoretical manuscript proposes and describes a model for research and practice which brings into alignment interdisciplinary thinking and interdisciplinary collaboration.

### **Model of Dualistic Interdisciplinarity**

The Model of Dualistic Interdisciplinarity, pictured in Figure 1, combines interdisciplinary collaboration and interdisciplinary thinking. Each element of the model is described below the figure. Figure 1

*Model of Dualistic Interdisciplinarity***Interdisciplinary Thinking**

Interdisciplinary thinking is defined as *understanding how multiple disciplines interact within a given problem or phenomenon* and refers to the individual learner element of the model. Interdisciplinary thinking represents the foundation of the model, as an individual's understanding of multiple disciplines is required to engage in collaborative work with individuals representing those disciplines (Bossio et al., 2013). Importantly, however, interdisciplinary thinking does not suggest an individual become an expert in all disciplines; instead, interdisciplinary thinking requires an individual acknowledge the contributions, or potential contributions, of multiple disciplines on a given problem or phenomenon. Pragmatically, the development of interdisciplinary thinking requires learners be engaged in experiences which continually illuminate the multitude of disciplines which contribute to, or could contribute to, a holistic understanding of a problem or phenomenon (McKim et al., 2017b; Scherer et al., 2019).

Within AFNR Education research, interdisciplinary thinking is often studied within the context of science, technology, engineering, and mathematics (STEM) integration. A 2019 study by Scherer et al. illuminated STEM integration occurs through a variety of instructional approaches, including problem-based learning, hands-on experiences, experiential learning, inquiry-based instruction, and competitions. The most commonly studied approaches were problem-based instruction, defined by learners engaging in real-world problems, design challenges, or AFNR-related projects and hands-on experiences which include the physical manipulation of objects related to the topic being learned (Scherer et al., 2019).

**Interdisciplinary Collaboration**

Interdisciplinary collaboration is defined as *working with individuals who represent multiple disciplines on a given problem or phenomenon* and refers to the social element of the model. Interdisciplinary collaboration represents the operationalization of interdisciplinary thinking; recognizing collaboration is essential for complex problem solving, the ability to utilize interdisciplinary thinking within collaborative teams is essential (Bossio et al., 2013; Newell, 2010). Pragmatically, interdisciplinary collaboration requires learning opportunities whereby individuals representing diverse disciplines are brought together to collaborate on a problem or phenomenon. In an educational context, interdisciplinary collaborations can be fostered between students enrolled in different disciplinary courses (e.g., students in science, engineering, and

economics courses) *or* students enrolled in the same course who enact the roles of different disciplinary experts when discussing a problem or phenomenon (McKim et al., 2017b).

The notion of interdisciplinary collaboration emerges from work on collaborative learning. Grounded in social learning theory, collaborative learning is described as two or more individuals working together in shared authority and acceptance to build consensus through cooperation (Laal & Ghodsi, 2012). Interdisciplinary collaboration expands this definition by highlighting each individual within the group represents a unique area of expertise. Five elements are important to fostering successful collaborations, (a) positive interdependence, (b) face-to-face interaction, (c) individual accountability and responsibility to achieve group goals, (d) use of interpersonal skills, and (e) continual group process evaluation and refinement (Johnson & Johnson, 1994). When successful, collaborative learning yields social benefits (e.g., understanding of diversity), psychological benefits (e.g., increased self-esteem), and academic benefits (e.g., improved critical thinking skills) (Laal & Ghodsi, 2012).

### **Transfer of Interdisciplinarity**

Existing research provides the foundation of knowledge from which interdisciplinary thinking and interdisciplinary collaboration are explored. However, when combined within the Model of Dualistic Interdisciplinarity, the transitions between these two elements are foregrounded. Importantly, these transitions provide the novelty and utility of this new way of thinking about interdisciplinarity. The first of these transitions is shifting from interdisciplinary thinking to interdisciplinary collaboration. *Transfer of interdisciplinarity* is defined as *the ability to utilize interdisciplinary thinking within collaborative groups* and represents the shift from an individual to social context within the model. Pragmatically, transfer of interdisciplinarity requires educational experiences which attend to four outcomes (see Table 1 for descriptions): (a) the ability to work in teams, (b) an appreciation for diversity, (c) an understanding of the problem or phenomenon, and (d) an awareness of individual expertise related to the problem or phenomenon.

Table 1

*Transfer of Interdisciplinarity Skills*

Pragmatic Skill	Description
The ability to work in teams.	A range of knowledge (e.g., stages of team development, member roles) and skills (e.g., emotional intelligence, conflict management) are associated with working in teams. Learning experiences must include opportunities for learners to construct this knowledge and develop these skills through content and practice.
An appreciation for diversity.	In preparation for working in interdisciplinary teams, individuals should engage in learning experiences which highlight the essential nature, and utility, of diverse perspectives, values, and backgrounds coming together.
An understanding of the problem of phenomenon.	Transitioning from an individual to collaborative context, learners must have a robust understanding of the problem or phenomenon in which they will be contributing ideas.
An awareness of individual expertise related to problem of phenomenon.	Interdisciplinary collaborations require each individual have an area of expertise they contribute to the problem of phenomenon. Therefore, the transition to collaboration requires individuals are aware of the expertise they bring to the collaboration.

**Experiential Interdisciplinarity**

The second transition is from interdisciplinary collaboration to interdisciplinary thinking. *Experiential interdisciplinarity* is defined as *the ability to utilize interdisciplinary collaborations to inform interdisciplinary thinking* and represents the shift from the social to individual context within the model. Pragmatically, experiential interdisciplinarity requires educational experiences which attend to three outcomes (see Table 2 for descriptions): (a) the ability to develop knowledge through reflection upon experiences, (b) an ability to process through cognitive disequilibrium, and (c) an understanding of how to operationalize diverse ideas.

Table 2

*Experiential Interdisciplinarity Skills*

Pragmatic Skill	Description
The ability to develop knowledge through reflection upon experiences.	As informed by the experiential learning theory (Kolb, 1984), learning emerges from making meaning out of experience. Therefore, learning experiences must develop learners' ability to construct knowledge as lived experiences are reflected upon.
An ability to process through cognitive disequilibrium.	When working in interdisciplinary teams, knowledge is gained through the synergy of different disciplinary perspectives coming together. This melding of perspectives often juxtaposes a singular (i.e., individual or discipline) viewpoint; thus, individuals must cope with, and leverage, the resulting cognitive disequilibrium.
An understanding of how to operationalize diverse ideas.	In concert with cognitive disequilibrium, individuals must be prepared to incorporate the melded perspectives resulting from interdisciplinary collaborations into their own interdisciplinary thinking, including understanding how this new viewpoint changes their interaction with, and understanding of, problems and phenomena.

### Conclusions and Discussion

With increasing momentum, “interdisciplinary” is becoming part of educational nomenclature (Boix Mansilla et al., 2006; Klein, 2008). However, evaluation of the concept yields two ways of conceptualizing the term: (a) a characteristic of an individual’s thinking and (b) a feature of a collaborative group. This theoretical manuscript provides a model which delineates these two features while also showcasing their relationship and transitions between the two concepts of interdisciplinarity. The resulting model can be used by researchers, teachers, and other stakeholders to increase the interdisciplinarity, both thinking *and* collaboration, of AFNR Education.

In addition to defining and differentiating interdisciplinary thinking and interdisciplinary collaboration, the model highlights two transitional processes, transfer of interdisciplinarity (i.e., shifting from interdisciplinary thinking to interdisciplinary collaboration) and experiential interdisciplinarity (i.e., shifting from interdisciplinary collaboration to interdisciplinary thinking). These transitional processes transform the Model of Dualistic Interdisciplinarity from a theoretical conceptualization to a practical tool for AFNR educators to encourage learners to be more individually and collaboratively interdisciplinary. Furthermore, the identification of outcomes (see Tables 1 and 2) associated with both transfer of interdisciplinarity and experiential interdisciplinarity provide a roadmap for preparing learners to shift between interdisciplinary thinking and interdisciplinary collaboration.

The transitional processes found within the model also illuminate the cyclical nature of interdisciplinary learning. The cyclical nature implies individuals must navigate transitions between individual and social learning opportunities, wherein individual experiences strengthen disciplinary perspective while acknowledging the value, or potential value, other disciplines provide to a phenomenon or problem. Likewise, collaborative experiences provide learners with

opportunities to cross disciplinary boundaries in collaboration with individuals diverse in background, knowledge, and perspectives to meld ideas, understanding, and solutions on a phenomenon or problem. Throughout the interdisciplinary cycle, educators should facilitate transitions between individual and collaborative experiences while also attending to transfer of interdisciplinarity and experiential interdisciplinarity.

The Model of Dualistic Interdisciplinarity has the potential to unify research and practice-based efforts in education focused on interdisciplinarity. As Scherer et al. (2019) suggested in their review of interdisciplinary scholarship within AFNR Education, the lack of a comprehensive teaching framework for STEM integration within AFNR leaves scholars and practitioners without a guide to promote complementary efforts. By linking interdisciplinary thinking and interdisciplinary collaboration in a cyclical process of interdisciplinary learning, the Model of Dualistic Interdisciplinarity empowers both educators and researchers with a comprehensive framework for understanding, and increasing, the development of interdisciplinary knowledge and skills throughout AFNR Education.

### Recommendations

As a draft model of the relationship between interdisciplinary thinking and interdisciplinary collaboration, continued work is needed to strengthen the ideas presented. Therefore, recommendations emerging from this work favor research over practice. Scholars are encouraged to challenge, critique, and expand upon the Model of Dualistic Interdisciplinarity using theoretical, conceptual, and/or empirical approaches. Additionally, pragmatic evaluations of the model within aligned educational spaces are encouraged alongside evaluations of educators who have implemented these approaches. Finally, from a holistic perspective of AFNR Education, our discipline should be actively seeking opportunities to emerge as a leader in the scholarship and practice of interdisciplinary thinking and interdisciplinary collaboration. The interdisciplinary context of AFNR systems provides a valuable head start to inform education, as a whole, on these important topics.

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