

Interlinking-Based Teaching: A Study on the Development of the Interlinking Index Framework

Salih Bozkurt, Oguz Ozdemir

Mugla Sıtkı Koçman University, Muğla, Türkiye

Abstract: In interlinking-based teaching, designing and implementing instructional content and practices based on interlinking has become a necessity for solving real-life problems and understanding various phenomena encountered in daily life. However, the lack of comprehensive models that guide interlinking-based instructional processes constitutes a significant gap in the literature. In this context, the present study aims to develop an analysis tool that can guide the development, implementation, and evaluation of interlinking-based instructional content. To this end, a comprehensive literature review was conducted, and the collected data were analyzed through content analysis by two researchers. The inter-coder reliability was calculated as 89%. Subsequently, an “interlinking index” was developed and submitted for expert review. Based on the feedback received from the experts, the index was revised and finalized. The resulting “analysis index” consists of 17 items grouped under four main dimensions, providing guidance for the development, implementation, and evaluation of interlinking-based instructional content. It is expected that this study will contribute to the dissemination and effective use of interlinking-based instructional activities.

Science Insights Education Frontiers 2026; 33(2):5345-5364.

DOI: 10.15354/sief.26.or193

How to Cite: Bozkurt, S., Ozdemir, O. (2026). Interlinking-based teaching: A study on the development of the interlinking index framework. *Science Insights Education Frontiers*, 33(2):5345-5364.

Keywords Interlinking Based Learning, Intradisciplinary, Multidisciplinary, Interdisciplinary, Transdisciplinary

About the Author: Salih Bozkurt, Institute of Educational Sciences, Mugla Sıtkı Koçman University, Muğla, Türkiye, Email: salih_4884@hotmail.com. ORCID: <https://orcid.org/0000-0002-9764-515X>

Oguz Ozdemir, Prof., Dr., Faculty of Education, Mugla Sıtkı Koçman University, Muğla, Türkiye, Email: oozdemir@mu.edu.tr. ORCID: <https://orcid.org/0000-0003-2032-323X>

Correspondence to: Salih Bozkurt at Mugla Sıtkı Koçman University in Türkiye.

Conflict of Interests: None

Funding: No funding sources declared.

AI Declaration: The authors affirm that artificial intelligence did not contribute to the process of preparing the work.

© 2026 Insights Publisher. All rights reserved.



Creative Commons NonCommercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed by the Insights Publisher.

Introduction

IT is now clearly evident that traditional instructional processes structured around a single discipline are insufficient in addressing the increasingly complex dynamics of the modern era. With the transition to the knowledge society, the competencies expected from individuals extend beyond specialization in a single domain; they also encompass the ability to synthesize knowledge from various fields, think multidimensionally, analyze problems from diverse perspectives, and develop interdisciplinary solutions. In this context, educational processes must go beyond the mere transmission of information and evolve into a structure that strengthens the individual's connection with real life, rendering learning meaningful and functional. Particularly, the cultivation of individuals capable of coping with unpredictable social, environmental, and technological challenges is no longer an option but a necessity of educational policy.

This need for transformation has led to the adoption of a holistic approach in education and the widespread implementation of instructional designs centered on interdisciplinary interaction.

At this point, the concept of interlinking-based instruction emerges as an innovative approach that aims to deepen and solidify student learning by establishing meaningful connections among the content, methodology, and value structures of different disciplines. However, addressing this approach solely on a theoretical level is insufficient; there is a clear need for original, applicable, and holistic models that can guide every phase of the instructional process. In an effective lesson plan, the most essential components to consider can be listed as “content,” “learning stakeholders,” “learning experiences,” and “learning outcomes.” However, most of the limited studies available in the literature focus only on specific elements of the interlinking process, which creates a significant gap for practitioners.

Building on this gap, the present study aims to develop an analytical tool that enables the systematic integration of interlinking-based instruction into all stages of the teaching process. The proposed “analytical tool” clarifies the key points that must be considered throughout the entire instructional sequence—from content planning to the assessment of learning outcomes. This study may serve as a guide not only for planning interlinking-based instruction but also for evaluating such instructional practices.

Approaches to Relating Different Courses/Contents in Education

When the content used in instructional processes is structured not only from the limited perspective of a single discipline but also through meaningful

connections with other disciplines, students' learning experiences become more holistic and functional. In this regard, curricula can be designed according to varying degrees of interlinking. This design may range from the most basic level—a single-discipline structure—to multidisciplinary, interdisciplinary, and ultimately transdisciplinary approaches. This perspective directly influences not only the content of the curriculum, but also the design of learning activities, the roles of learners, and the quality of learning outcomes.

Throughout the twentieth century, a holistic understanding in education was regarded not only as an area of interest but also as a necessity. The concept first appeared in the 1920s within the project approach, in the 1930s within the core curriculum, and in the 1940s and 1950s within problem-centered core curriculum models (Klein, 2006). During this period, terms such as “integration,” “integrated curriculum,” “the foundation of unified education,” “integration of content,” “integration of process,” and “unified/integrated program” were widely used. Beginning in the 1970s, new concepts such as “cross-disciplinary,” “interdisciplinary,” and “multidisciplinary” came into use. In this context, several models that explain how interdisciplinary connections should be established were developed successively by Jantsch (1972), Jacobs (1989), Fogarty (1991), and Smith & Karr-Kidwell (2000).

Jantsch (1972) described the shift from a reductive approach toward an integrative approach in five stages: disciplinary (within a single discipline), multidisciplinary, cross-disciplinary, interdisciplinary, and transdisciplinary. Jacobs (1989) examined interdisciplinary connections under six headings: “discipline-based content design,” “parallel discipline design,” “complementary discipline units/courses,” “interdisciplinary units/courses,” “integrated day,” and “complete program.” Fogarty (1991) identified ten methods for interdisciplinary programming, grouping them into three categories: (1) within a single discipline, (2) across multiple disciplines, and (3) among and within learners. Drawing on these approaches, Smith and Karr-Kidwell conceptualized interdisciplinary connections along a linear continuum, defining them as a progression from disciplinary approaches toward transdisciplinary approaches.

The framework proposed by Smith and Karr-Kidwell (2000) classifies levels of content integration in education along a spectrum ranging from disciplinary to transdisciplinary approaches, offering educators a theoretical lens for curriculum development. At one end of this spectrum, content presented at the disciplinary level aims to equip students solely with the terminology and methodologies of a specific field. At the transdisciplinary end, instructional practices are designed to center on real-life problems, enabling students to develop multidimensional thinking, research, problem-solving and interdisciplinary synthesis skills.

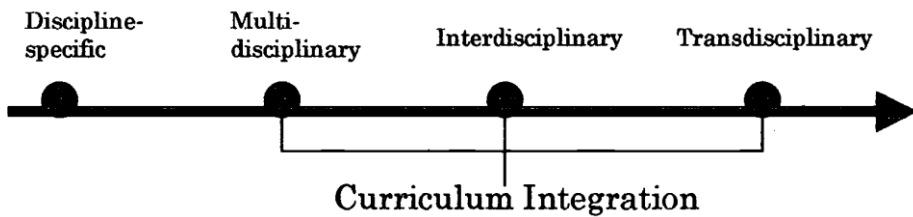


Figure 1. Levels of content development based on interlinking in teaching (Smith & Karr-Kidwell, 2000)

One of the most significant contributions of this approach is its emphasis on transforming the student from a passive recipient of knowledge into an active learner. In interdisciplinary and transdisciplinary designs, students are expected to integrate information from multiple fields to arrive at meaningful outcomes, which plays a critical role in fostering higher-order thinking skills. Moreover, this structure promotes collaboration among teachers, inter-institutional partnerships, and learning opportunities that are connected to the broader community, thereby creating a more inclusive and life-integrated educational experience.

In this context, structuring instructional programs based on content integration has the potential to enhance not only individual learning outcomes but also societal benefit. **Figure 1** below visually illustrates how instructional content can be classified according to different levels of integration and highlights the key features of each level (Smith & Karr-Kidwell, 2000).

Intradisciplinary

A “discipline” refers to a teachable body of knowledge defined by its unique terminology, theoretical framework, instructional methods, modes of practice, and knowledge content (Aktan, 2009). Disciplines serve the function of generating and transmitting systematic knowledge within a specific field, each grounded in its own epistemological foundations, methodological approaches, and evaluative criteria. Historically, modern education systems have been shaped in response to the needs of industrial societies, prioritizing curriculum structures centered on single disciplines to foster specialization. This model has effectively supported the development of a workforce suitable for production-oriented economies, and instructional practices have been designed accordingly within a disciplinary framework.

In disciplinary-based instructional programs, students are equipped exclusively with the concepts, content, rules, and problem-solving strategies of the relevant subject area, while opportunities for interdisciplinary connec-

tions are largely limited. As a result, knowledge is transmitted within bounded domains, which can hinder students' ability to think multidimensionally or relate their learning to broader contexts. However, in light of the evolving demands of today's knowledge society, it is increasingly evident that the restrictive structure of disciplinary teaching must be reevaluated. Contemporary educational approaches emphasize the need for disciplinary structures to become more flexible, interconnected, and life-relevant.

Accordingly, the disciplinary model should not be regarded as a completely isolated structure; over time, it has gradually incorporated elements from other disciplines. Student-centered teaching approaches such as contextual learning, problem-based learning, and case-based instruction have begun to introduce a limited degree of interconnection within the disciplinary framework. For example, when teaching environmental pollution in science classes, connections may be made to sustainability examples drawn from social studies, or mathematical measurement concepts may be linked with time-tracking practices in physical education classes. These types of applications serve as examples of contextual integration within disciplinary instruction, allowing students to synthesize knowledge from different domains and thereby achieve more meaningful and lasting learning.

As emphasized by the Ministry of National Education (Milli Eğitim Bakanlığı) (2024), for disciplinary instruction to become more effective and functional, it is recommended that curricula be made contextually relevant, enriched with examples from different subject areas, and supported by learning environments that promote multidimensional thinking. In this regard, rather than viewing the disciplinary approach as an end in itself, it should be considered a foundational level that facilitates the transition to more integrative approaches. Such a perspective aligns more closely with contemporary educational paradigms.

Multidisciplinary

The multidisciplinary approach is a model of integration that aims to address a specific topic or theme through the perspectives of different disciplines during the instructional process. In this approach, each discipline contributes to the process while maintaining its distinct structure and boundaries; that is, no direct integration of content or methodology takes place between the disciplines, but each addresses the same theme from its unique perspective (Klein, 2006). Accordingly, multidisciplinary instructional practices involve parallel planning of different subject areas around a central theme while clearly preserving the boundaries between disciplines. The goal of each discipline is to equip students with knowledge and skills within its context.

Despite conducting classes independently, the multidisciplinary approach directs the contributions of all disciplines toward a common theme.

For example, under the theme of “nature,” science classes may focus on ecosystems, social studies may explore human-nature interaction, and Turkish language arts may cover literary texts centered on nature. While each course proceeds according to its internal dynamics, students are expected to establish cognitive connections among these courses and develop a more holistic understanding. Therefore, rather than facilitating direct transitions between disciplines, the focus is on students’ ability to mentally integrate knowledge acquired from multiple disciplines (Helmane & Briška, 2017; Malakar & Zeliang, 2024).

One pedagogical advantage of this approach is that it enables students to gain knowledge from various disciplines, thereby enriching the learning process. Students acquire specific knowledge and skills in each course while simultaneously developing the habit of examining a common theme from different viewpoints. Such an approach is particularly functional for constructing thematic learning structures at the primary and secondary education levels. However, it is important to note that due to the limited degree of disciplinary integration, the responsibility for synthesizing knowledge across subjects largely rests with the students themselves. Teachers guide this process indirectly.

Cooperative learning, group work, and theme-based project methods often support multidisciplinary approaches in instructional activities (Liu et al., 2024). Students learn through interaction with both their peers and teachers in the classroom. In this context, social learning environments emerge as a critical component of multidisciplinary instruction. Students compare information from various sources, attempt to synthesize it, and develop their critical thinking skills. However, because interdisciplinary concepts, methods, or solutions are not directly integrated within this approach, students may have limited opportunities to develop the ability to perform interdisciplinary synthesis.

Assessment and evaluation processes base their decisions on the level of knowledge and skills acquisition specific to each course content. In other words, students are evaluated based on whether they have achieved the objectives unique to each discipline. Although the multidisciplinary structure enables the integrated presentation of content, its use indicates that the assessment criteria still remain independent. As a result, while the multidisciplinary approach broadens the scope of learning, it also serves as a transitional bridge toward more advanced approaches that aim for deep interdisciplinary integration.

Interdisciplinary

Instructional practices structured according to the interdisciplinary approach represent a teaching philosophy that emphasizes the interactive integration of

knowledge and methods from multiple disciplines. While the boundaries of each subject or content area can still be defined within this approach, they are considerably more flexible than in the multidisciplinary model. In other words, in interdisciplinary instruction, permeability between disciplines is prioritized; although disciplinary boundaries are not completely eliminated, they are no longer barriers to instructional design (Helmane & Briška, 2017).

Whereas the primary aim of multidisciplinary approaches is to provide students with discipline-specific knowledge and skills, interdisciplinary approaches focus on enabling students to analyze, relate, and synthesize information from various disciplines to generate new meanings (Klein, 2006; Newell, 1990). Thus, interdisciplinary teaching not only involves acquiring knowledge but also emphasizes the development of interdisciplinary competencies and the application of these skills in creative problem-solving processes. Cognitive processes such as analysis, synthesis, and evaluation are activated as students engage with knowledge clusters, concepts, methods, and modes of thinking from multiple disciplines. Through this process, students construct meaningful wholes (Choi & Pak, 2006).

In interdisciplinary instructional practices, learning is largely built upon the personal meanings developed by the student. Students are not merely recipients of existing knowledge; rather, they reconstruct this knowledge and integrate it into their own cognitive frameworks. Asking their own questions, forming hypotheses, conducting research, and engaging in multidimensional thinking are fundamental components of this approach (Helmane & Briška, 2017). As such, the learning process allows students to develop personal insights and produce original outcomes.

Furthermore, the interdisciplinary approach offers structures that enhance interaction within the learning environment. Multifaceted activities are designed to support students' skills in collaboration, problem-solving, writing, design, abstract thinking, and creativity (Drake & Burns, 2004). In these processes, student-centered methods such as group work, project-based learning, and inquiry-based learning are frequently employed. Teachers take on the role of facilitators who guide and support the learning journey.

In interdisciplinary teaching, the process of collaborative learning is experienced not only among students but also actively in interactions between teachers, as well as between students and teachers. This approach highlights the critical importance of communication and planning among teachers in designing interdisciplinary instruction. The teaching process is conducted collectively; all stakeholders engage in interaction during the structuring of content, implementation phases, and assessment stages (Helmane & Briška, 2017).

From this perspective, the interdisciplinary approach is one of the most prominent and robust examples of association-based teaching. This approach is not limited to content integration; it also prioritizes interdiscipli-

nary interaction at all stages of instructional design, including planning, implementation, and evaluation. Fogarty and Pete (2009) describe this structure as “the most advanced form of association-based learning,” emphasizing that meaningful interaction and collaborative construction processes occur throughout all components of instruction. Therefore, the interdisciplinary approach plays a crucial role, both theoretically and practically, in establishing holistic, flexible, and interactive learning environments needed in contemporary education systems.

Transdisciplinary

In both multidisciplinary and interdisciplinary approaches, the boundaries of the disciplines to which the associated courses or contents belong remain clearly defined. Although these boundaries become more flexible within the interdisciplinary structure, a traceable framework for transitions between disciplines still exists. In contrast, the transdisciplinary approach eliminates disciplinary boundaries entirely and presents a more advanced learning paradigm that handles knowledge within a structure that transcends disciplines (Nicolescu, 1999). In this approach, knowledge is constructed within academic disciplines and interwoven with real life, social needs, and individual experiences. The teaching processes are shaped around real-life problems that students identify based on their lives, environmental issues, or societal needs.

In the transdisciplinary teaching model, instructional content is created through the integration of knowledge, skills, and methods from various disciplines to address authentic problems that students encounter in real life. In this respect, it is not only about establishing connections across disciplines but also about developing a student-centered instructional approach grounded in real-life relevance and original learning experiences (Helmane & Briška, 2017; Wilcox & Kueffer, 2008). The courses and contents involved in such integration are not merely considered classroom materials but rather meaningful constructs that are directly related to the student’s social, cultural, and physical environment. Such integration enables knowledge to be internalized not only conceptually but also experientially (Verma & Verma, 2024).

The transdisciplinary approach focuses on complex and multidimensional problems aligned with societal values and genuine needs. Therefore, it prioritizes not only individual learning goals but also outcomes that contribute to public good (Pohl & Hadorn, 2008). One of the core aims of this approach is to help students develop real-life skills—such as critical thinking, collaboration, social responsibility, systematic problem-solving, and entrepreneurship (Klein, 2006; Danermark, 2019). Learning is not limited to interactions among individuals; it also occurs through multi-stakeholder col-

laborations between schools, communities, public institutions, and civil society organizations. This structure enables learning to transcend the walls of the school and become integrated with societal realities (Helmane & Briška, 2017).

In transdisciplinary instructional practices, problem-based learning (PBL) and project-based learning methods are generally preferred (Choi & Pak, 2006; Fogarty & Pete, 2009). In these methods, teachers do not structure the curriculum based on a classical sequence of topics but rather around the questions and problems raised by students. Students participate actively in this process, conducting research and integrating knowledge from various disciplines to produce solutions. Projects focusing on issues such as environmental pollution, social inequality, energy conservation, or digital security offer students the opportunity to establish strong connections with real life. In such learning experiences, the aim is not merely to acquire theoretical knowledge but to apply it to real-life contexts and develop essential life skills.

The philosophy of this approach also guides the structure of the assessment process. Evaluation does not focus solely on whether the student has learned the content of a subject but also on the extent to which they have addressed the given problem, how effectively they have integrated different disciplines into the solution process, and what kind of interaction they have established with the community. Accordingly, assessment in transdisciplinary teaching is process-oriented, multi-sourced, and closely connected to real life. Criteria such as the sustainability, applicability, and social benefit of the solutions developed by students necessitate a holistic evaluation model that goes beyond traditional knowledge tests.

In conclusion, the transdisciplinary approach represents an innovative learning model that centers not only on the transmission of academic knowledge but also on understanding, interpreting, and transforming the world in which the individual lives. In this respect, it plays a critical role in equipping students with 21st-century skills and cultivating active citizens at both the individual and societal levels.

Teaching Studies and Examples Based on Association of Different Courses/Contents in Literature

Instructional approaches based on interdisciplinary integration have been gaining increasing importance, particularly in response to the need for more holistic solutions in education systems confronted with the dynamic structure of the knowledge society and today's complex problems. Despite this growing emphasis, there is a notable scarcity of comprehensive studies in the literature that extensively address such approaches. The limited number of educational studies focusing on interdisciplinary and transdisciplinary integra-

tion highlights the growing need for structural models that can guide instructional design processes.

Some existing studies, particularly within the framework of the multidisciplinary approach, have focused on instructional practices that bring together different disciplines around specific themes. For instance, programs have been designed to combine interdisciplinary content in areas such as sustainability education, rehabilitation programs for the elderly, and nursing education (Liu et al., 2024; Malakar & Zeliang, 2024; Omar & Otaka, 2025; Sherren, 2005). While such studies aim to enable students to develop broad perspectives by utilizing information from different fields side by side, the level of integration often remains superficial, and deep interdisciplinary synthesis tends to be limited.

On the other hand, instructional practices based on interdisciplinary approaches are more focused on developing students' cognitive, creative, and problem-solving skills in an interdisciplinary context. For example, in a study by English and Mousoulides (2015), 6th-grade students were asked to redesign a collapsed bridge using integrated content from mathematics, science, arts, and engineering. Similarly, Gortmaker's (1999) instructional model brought together themes related to healthy eating and physical activity in 5th-grade mathematics, science, language arts, and social studies. Other examples include middle school-level interdisciplinary projects in chemistry aimed at enhancing engineering skills (Ling et al., 2024); STEM-focused instruction integrating physics, chemistry, and biology in high schools (Robledo & Roleda, 2024); and instructional content focused on sustainability competencies for higher education students (Azkarate et al., 2025). Additionally, programs such as the patient-centered program developed by Schneider et al. (2024) also stand out as effective examples of interdisciplinary learning at the higher education level.

Instructional practices focusing on transdisciplinary approaches, in contrast, aim not only to enable students to acquire knowledge but also to transform and apply that knowledge in real-life contexts to contribute to society. In this context, Atkinson's (2024) marketing education, sustainability projects by Olvitt et al. (2024), medical and digital health education models by Kröplin et al. (2024), and the climate change and public health curriculum by Verma & Verma (2024) are important examples showing how transdisciplinary teaching can be used in different areas. These studies offer students the opportunity to go beyond learning and develop a sense of participation and responsibility through projects that are integrated with life and involve community engagement.

Despite all these examples, a significant gap remains in the field of education regarding a comprehensive and systematic approach that fully encompasses all components of integration-based instructional processes. Existing studies in the literature tend to focus either on content development or

on implementation phases, while other critical components—such as learning experiences, assessment strategies, and collaboration among stakeholders—are often overlooked. In this context, there is a clear need for a comprehensive model capable of analyzing the instructional process through the lenses of disciplinary, multidisciplinary, interdisciplinary, and transdisciplinary approaches and guiding instructional design accordingly.

Developed in response to this need and introduced in the present study, the “interlinking index” is an original and comprehensive instrument designed to determine and structure the levels of interlinking within instruction. This analysis offers a theoretical framework and provides a guiding structure for practitioners throughout all phases of the instructional process—from planning to assessment. This helps create learning environments that focus on integration in teaching and makes it easier to manage these processes effectively.

Method

The study was conducted using document analysis, one of the qualitative research methods. Yıldırım and Şimşek (2013) defined document analysis as “the systematic examination of written materials that contain information about the phenomenon or phenomena targeted for investigation.” This method enables an in-depth analysis of existing information sources, thereby facilitating the development of a comprehensive theoretical framework on the research topic. Within this framework, the “interlinking index” was developed through a systematic literature review of studies related to interlinking-based (multidisciplinary, interdisciplinary, and transdisciplinary) instructional practices, supported by expert opinions in the field.

The gathered data were analyzed based on expert feedback, and categories were created to organize how different courses connect with each other. In light of the feedback obtained from experts, patterns corresponding to different levels of interconnection between courses were identified, and an interlinking index was developed based on these patterns. The content of this analysis tool was constructed upon both theoretical foundations and practical applications and was introduced and exemplified to enhance its usability in instructional processes.

In this context, the research method not only classified the existing data but also provided a systematic foundation for the design and validation of a new interlinking index.

Sample

The sample of this study consists of 23 publications, including 18 peer-reviewed articles and 5 online academic books obtained from the ERIC (Ed-

Education Resources Information Center) and Scopus databases, all focusing on instructional practices designed to relate or integrate different courses or content areas.

In the studies included in the sample, particular attention was given to examining the levels of association in relation to instructional planning, content structuring, interdisciplinary collaboration, student engagement, assessment strategies, and learning outcomes. The findings derived from these publications served as the primary data source for developing the analytical framework of the study and contributed to shaping both the theoretical and practical dimensions of the proposed “interlinking index”.

Data Collection and Analysis

In developing the interlinking index for the study, data were collected through the analysis of documents obtained via a systematic literature review. The following steps were followed throughout this process:

- First, based on the literature review on association-based instructional practices and expert opinions, the key concepts to be used during the systematic search were identified. These concepts were defined as multidisciplinary, interdisciplinary, and transdisciplinary.
- Using the identified key concepts, studies published between 1900 and 2025 were retrieved through the Google Scholar search engine. The searches yielded a substantial number of sources related to interdisciplinary and cross-content association practices.
- Among the retrieved sources, only those that addressed association-based instructional practices and were published in English in academically recognized journals indexed in ERIC (Education Resources Information Center) and Scopus, as well as English-language books published by publishers listed in the Book Citation Index (BKCI), were included for evaluation. Through this process, 5 online academic books and 46 peer-reviewed articles were identified.

These studies were then examined for content relevance regarding the “associations between different courses/contents” across various educational levels, from primary to higher education. As a result of this screening, 18 peer-reviewed articles and 5 online academic books were included in the study. Thus, a total of 23 publications constituted the core dataset for the analysis process.

The publications analyzed within the scope of the study are as follows:

Aboelela et al. (2007), Danermark (2019), Drake & Burns (2004), Fogarty (1991), Fogarty & Pete (2009), Gillis et al. (2017), Helmane & Briška (2017), Hursh et al. (1983), Jacobs (1989), Jones (2010), Kaufman et al. (2003), Klein (2006), Kramer et al. (2007), Lattuca (2003), Malakar &

Zeliang (2024), Malik & Malik (2011), Moore & Smith (2014), Newell (1990), Nicolescu (1999), Odum & Barret (2008), Pohl & Hadorn (2008), Smith & Karr-Kidwell (2000), Wilcox & Kueffer (2008).

Analysis

The studies obtained on association-based instructional practices were analyzed using content analysis. In this process, the instructional practices identified within the selected publications—specifically those concerning the association of different subjects and content areas—were examined across four categories: “content,” “learning stakeholders,” “learning experiences,” and “learning outcomes.” For each category, the forms and levels of association present in the studies were coded, and based on these codes, a set of association indicators was derived.

Using these indicators, a draft interlinking index was developed. This draft tool was then reviewed by three experts in the field, and revised in line with their feedback to finalize the instrument. At this stage, the experts’ recommendations were taken into consideration to ensure both the conceptual coherence of the interlinking index and its practical applicability. As a result, a valid and reliable interlinking index grounded in both theoretical and practical foundations was established.

Validity and Reliability

In qualitative research, Guba and Lincoln (2001) propose the concept of trustworthiness instead of the notion of “rigor” commonly used in quantitative studies. Within this framework, they emphasize four fundamental criteria: credibility, transferability, dependability, and confirmability (Arastaman et al., 2018). Accordingly, the construct validity and reliability of the interlinking index developed to assess the interlinking practices of the instructional contents/courses within the scope of the study were meticulously evaluated based on the relevant literature and expert opinions. Necessary revisions were made, and the final version of the interlinking index was established.

To ensure coding reliability, the inter-coder agreement method was employed. For assessing agreement between coders, the lower threshold of 80% was adopted, and the formula proposed by Miles and Huberman [Reliability=Agreement/(Agreement+Disagreement) ×100] was used. The analysis yielded an agreement level of 89%, which exceeds the acceptable threshold. The remaining discrepancies were resolved through discussion, resulting in full consensus.

Table 1. Interlinking Index.

Components of Instruction	Indicators
Planning	The association is explicitly defined in the title.
	The contents of different courses are organized in a synchronized manner.
	The contents of different courses are organized in an asynchronized manner.
Content	A central content is flexibly/branchingly associated with other courses
	The contents of different courses are organized around a specific focal theme/topic.
	Associated contents focus on a real-life topic/problem/skill.
Objectives	Specific learning outcomes related to a particular discipline/topic are identified.
	Common learning outcomes across different fields are identified.
	Learning outcomes aimed at solving real-life problems are identified.
Learning Partners	Learning experiences are designed and implemented by a single instructor who integrates other related topics.
	Learning experiences are designed and implemented in collaboration with other relevant teachers/stakeholders.
	Learning experiences are designed and implemented by incorporating students' views and suggestions.
Learning Experiences/Practices	The associated content is implemented in practice.
	Associations are constructed through engaging with real-life problems.
Learning Outputs	Learning outcomes are evaluated solely from the perspective of one course (topic).
	Learning outcomes are evaluated in relation to the other associated course(s)/topic(s).
	Learning outcomes are evaluated with respect to solving the identified problem.

Findings

There is a need for standards that guide how association-based instruction should be structured not only during the content planning phase but also across all instructional components, including implementation, assessment, and stakeholder collaboration. In this regard, the interlinking index developed in the study incorporates indicators that can be considered throughout all stages of association-based instructional processes—namely, content development, the planning and execution of learning experiences, stakeholder engagement, and the evaluation of learning outcomes (**Table 1**).

The developed interlinking index addresses interlinking-based instruction from a holistic perspective, incorporating four core components: content development, learning stakeholders, learning experiences/practices, and learning outcomes. Within the “content development” dimension, three subcategories are defined: planning, focus, and learning outcomes. Each component includes specific indicators to assess the level and quality of interlinking.

The planning subcategory examines whether the interlinking strategy structures the content synchronously or sequentially. For example, teaching

“fractions” in 6th-grade math to prepare for the 7th-grade science topic “density” shows sequential interlinking, while teaching “efficient use of resources” in 5th-grade social studies and “recycling and sustainability” in 5th-grade science at the same time shows synchronous interlinking.

The focus subcategory evaluates whether the content is structured around a specific concept, skill, or real-life problem. For example, when “the solar system and planets” is chosen as the focus, science can address physical properties of planets, mathematics can calculate distances between planets, and design & technology can involve building a 3D model—demonstrating interdisciplinary integration. If a telescope design project is included, students can simultaneously apply science knowledge, mathematical scaling, and engineering design skills.

The learning outcomes subcategory assesses whether learning goals are defined separately for each discipline or integrated across disciplines. In separate definitions, students are expected to make connections between different disciplines; in integrated definitions, learning goals combine multiple disciplines. For example, when addressing the topic of energy, separate goals might be set for physics, chemistry, and biology, while an integrated approach might combine a science goal such as “drawing scientific conclusions about the importance of recycling for resource management” with a social studies goal like “interpreting the social impact of sustainable resource use.”

The stakeholder dimension evaluates whether not only teachers but also students, subject-matter experts, NGOs, and local authorities are involved in the instructional process. For instance, students investigating pollution in a water source might scientifically analyze the situation in science class, process data in mathematics class, and work with local governments and environmental organizations to develop solutions—thus establishing strong ties between classroom learning and real life.

The learning experience/practice dimension centers on students’ active roles in the learning process. Rather than being passive recipients of content, students are involved in planning and implementing instruction. For example, in the Finnish education system, teachers are expected to develop at least one multidisciplinary module each year with student participation (Helmane & Briška, 2017; Mård & Hilli, 2022). In such instruction, students identify a local issue, determine which disciplines and stakeholders can contribute to solving it, and co-manage the process.

Finally, the learning outcomes dimension evaluates the extent to which learning goals have been achieved, students’ abilities to establish interdisciplinary connections, and their competence in solving real-life problems. The assessment process extends beyond traditional exams and may include project-based products, performance tasks, and student presentations as alternative tools for measuring learning.

Discussion and Conclusion

Despite the increasing emphasis on interdisciplinary and holistic educational approaches, it is observed that academic studies focusing on interlinking-based instruction remain limited in number. Most of the existing literature concentrates on only one dimension of interlinking-based instruction—such as content planning, implementation, or assessment—thus failing to provide practitioners with comprehensive guidance. Moreover, many studies do not sufficiently articulate the theoretical framework underpinning the interlinking process and lack systematic solutions to the practical challenges encountered in instructional practices.

This gap highlights the need for a valid and applicable structural model that can be implemented across all phases of interdisciplinary teaching—from planning to assessment. In this regard, the present study introduces and thoroughly explains the “interlinking index” as an analytical tool that enables the comprehensive structuring of interlinking-based instructional processes. The developed interlinking index presents concrete indicators for interlinking-based practices across four fundamental components of instruction: content development, learning experiences, learning stakeholders, and learning outcomes.

The purpose of this interlinking index is to support the design of instructional activities that transcend the boundaries of individual disciplines by integrating knowledge, skills, and attitudes from multiple fields within a holistic perspective. Accordingly, the interlinking index provides clear and systematic guidance for practitioners on how to develop content through an interlinking-oriented approach, which pedagogical strategies to adopt in planning learning experiences, the nature of stakeholder roles throughout the process, and the criteria to be used in evaluating learning outcomes.

In this context, the study aims not only to contribute to the theoretical foundation of interlinking-based teaching but also to offer a unique framework for its practical implementation, thereby serving as a concrete guide for both educational researchers and instructional designers. It is thought that the created interlinking index can be effectively used in different educational levels and various subjects, and is expected to help improve teaching methods to meet today's educational requirements.

The “interlinking index” introduced in this study was developed within the limitations of the available literature. Undoubtedly, conducting similar studies in light of additional and more recent literature would be beneficial. Moreover, the interlinking index was constructed based on the literature review and the insights provided by relevant experts. However, beyond these foundations, there remains a need to test the developed interlinking index within actual instructional processes.

References

- Aboeela, S. W., Larson, E., Bakken, S., Carrasquillo, O., Formicola, A., Glied, S. A., Haas, J. & Gebbie, K. M. (2007). Defining interdisciplinary research: conclusions from a critical review of the literature. *Health Services Research*, 42(1p1), 329-346. DOI: <http://dx.doi.org/10.1111/j.1475-6773.2006.00621.x>
- Aktan, C. C. (2009). Change in higher education: global trends and new paradigms. *Journal of Organization and Management Sciences*, 1(2), 39-48.
- Arastaman, G., Öztürk Fidan, İ. & Fidan, T. (2018). Validity and reliability in qualitative research: a theoretical analysis. *YYU Journal of Education Faculty*, 15(1), 37-75. <http://dx.doi.org/10.23891/efdyyu.2018.61>
- Atkinson-Toal, A. (2024). Student value of a transdisciplinary approach to curriculum development. *Journal of Marketing Education*, 1-17. DOI: <https://doi.org/10.1177/02734753241288182>
- Azkarate, A., Esparta, J., Enekotegi, I., Yarritu-Guinea, M., Bodes, R., Lasa, A., Arnedo, N., Bustamante, M., Txurruka, I. & Miranda, J. (2025). Evaluation of an interdisciplinary collaborative learning activity between university and vocational education and training students for sustainability competence development. *Inted2025 Proceedings*, 4029-4034. DOI: <http://dx.doi.org/10.21125/inted.2025.1024>
- Choi, B. C., & Pak, A. W. (2006). Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. *Clinical & Investigative Medicine*, 29(6), 351-364.
- Danermark, B. (2019). Applied interdisciplinary research: a critical realist perspective. *Journal of Critical Realism*, 18(4), 368-382, DOI: <http://dx.doi.org/10.1080/14767430.2019.1644983>
- Drake, S.M. & Burns, R.C. (2004) Meeting Standards Through Integrated Curriculum. Association for Supervision and Curriculum Development.
- English, L. D. & Mousoulides, N. (2015). Bridging STEM in a real-world problem. *Mathematics Teaching in the Middle School*, 20(9), 532-539.
- Fogarty, R. (1991). Ten ways to integrate curriculum. *Educational Leadership*, 49(2), 61-65.
- Fogarty, R. J., & Pete, B. M. (2009). How to integrate the curricula. Corwin Press.
- Gillis, D., Nelson, J., Driscoll, B., Hodgins, K., Fraser, E., & Jacobs, S. (2017). Interdisciplinary and transdisciplinary research and education in Canada: A review and suggested framework. *Collected Essays on Learning and Teaching*, 10, 203-222. DOI: <http://dx.doi.org/10.22329/celt.v10i0.4745>
- Gortmaker, S. L., Cheung, L. W., Peterson, K. E., Chomitz, G., Cradle, J. H., Dart, H., Fox, M. K., Bullock, R. B., Sobol, M. A., Colditz, G., Field, A. E. & Laird, N. (1999). Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children: eat well and keep moving. *Archives Of Pediatrics & Adolescent Medicine*, 153(9), 975-983. DOI: <http://dx.doi.org/10.1001/archpedi.153.9.975>
- Guba, E. G., & Lincoln, Y. S. (2001). Guidelines and checklist for constructivist (a.k.a. fourth generation) evaluation. https://study.sagepub.com/sites/default/files/guba_and_lincoln_-_2001.pdf
- Helmane, I. & Briška, I. (2017). What is developing integrated or interdisciplinary or multidisciplinary or transdisciplinary education in school?. *Journal of Pedagogy and Psychology Signum Temporis*, 9(1), 7-15. DOI: <http://dx.doi.org/10.1515/sigtem-2017-0010>
- Hursh, B., Haas, P., & Moore, M. (1983). An interdisciplinary model to implement general education. *Journal of Higher Education*, 54 (1), 42-49.
- Jacobs, H. H. (1989). *Interdisciplinary curriculum: Design and implementation*. Association for Supervision and Curriculum Development, 1250 N. Pitt Street, Alexandria, VA 22314.
- Jantsch, E. (1972). Inter- and transdisciplinary university: A systems approach to education and innovation. *Higher Education*, 1(1), 7-37.
- Jones, C. (2010). Interdisciplinary approach-advantages, disadvantages, and the future

- benefits of interdisciplinary studies. *Essai*, 7(1), 26.
- Kaufman, D., Moss, D. M., & Osborn, T. A. (Eds.). (2003). *Beyond the boundaries: A transdisciplinary approach to learning and teaching*. Greenwood Publishing Group.
- Klein, J. (2006). A platform for a shared discourse of interdisciplinary education. *JSSE-Journal of Social Science Education*, 5 (4), 10-18.
- Kramer, P., Ideishi, R. I., Kearney, P. J., Cohen, M. E., Ames, J. O., Shea, G. B., Schemm, R., & Blumberg, P. (2007). Achieving curricular themes through learner-centered teaching. *Occupational Therapy in Health Care*, 21(1/2), 185–198. DOI: http://dx.doi.org/10.1300/J003v21n01_14
- Kröplin, J., Maier, L., Lenz, J. H., & Romeike, B. (2024). Knowledge transfer and networking upon implementation of a transdisciplinary digital health curriculum in a unique digital health training culture: prospective analysis. *JMIR Medical Education*, 10, e51389.
- Lattuca, L. (2003). Creating interdisciplinarity: Grounded definitions from the college and university faculty. *History of Intellectual culture*, 3(1), 1-20.
- Ling, Y., Zhou, L., Zhang, B., & Ren, H. (2024). Developing middle school students' problem-solving ability through interdisciplinary project-based learning. *Education for Chemical Engineers*, 46, 43-53. DOI: <https://doi.org/10.1016/j.ece.2023.11.001>
- Liu, J., Liu, F., Zhang, F., Fang, J., Li, C. & Liu, S. (2024). Multidisciplinary-based design of a nursing informatics curriculum. In *Innovation in Applied Nursing Informatics* (129-133). IOS Press
- Malakar, D. & Zeliang, L. (2024). A step towards sustainable development: multidisciplinary approach in curriculum. *The Academic*, 10 (2). 315-325. DOI: <http://dx.doi.org/10.5281/zenodo.14102413>
- Malik, A. S. & Malik, R. H. (2011). Twelve tips for developing an integrated curriculum, *Medical Teacher*, 33 (2), 99-104. DOI: <http://dx.doi.org/10.3109/0142159X.2010.507711>
- Mård, N. & Hilli, C. (2022). Towards a didactic model for multidisciplinary teaching - a didactic analysis of multidisciplinary cases in Finnish primary schools, *Journal of Curriculum Studies*, 54(2), 243-258, DOI: <http://dx.doi.org/10.1080/00220272.2020.1827044>
- MEB. (2024). Türkiye century education model: Curricula common text. T.C. Ministry of National Education. Available at: <https://tymm.meb.gov.tr/ortak-metin>
- Moore, T. J. & Smith, K. A. (2014). Advancing the state of the art of STEM integration. *Journal of STEM Education: Innovations and Research*, 15(1), 5-10.
- Newell, W. H. (1990). Interdisciplinary curriculum development. *Issues in Integrative Studies*, 8, 69–86.
- Nicolescu, B. (1999). The transdisciplinary evolution of learning. In *Symposium on Overcoming the Underdevelopment of Learning at the Annual Meeting of the American Educational Research Association*, Montreal, Canada.
- Odum, E.P. & Barret, G.W. (2008). *Fundamentals of ecology*. (K. Işık, Trans.; 2nd ed.). Ankara: Palme Publishing.
- Olvitt, L., Davies, M., Ebrahim, A. I. & Cockburn, J. (2024). Transdisciplinary curriculum design for sustainability transitions: A reflective dialogue. *South African Journal of Science*, 120(9/10), 1-8. DOI: <https://doi.org/10.17159/sajs.2024/17884>
- Omar, Z. & Otaka, Y. (2025). Design and implementation of a community-based rehabilitation curriculum for training multidisciplinary rehabilitation teams to serve people aging with disabilities. *Fujita Medical Journal*, 11 (1), 1-10. DOI: <https://doi.org/10.20407/fmj.2023-019>
- Pohl, C. & Hadorn, G. H. (2008). Core terms in transdisciplinary research. *Handbook Of Transdisciplinary Research*, 427-432.
- Robledo, D. A. R. & Roleda, L. S. (2024). Power of microbes: utilization of improvised microbial fuel cell (IMFC) as an interdisciplinary learning activity in teaching bioelectricity. *Journal of Microbiology and Biology Education*, 25(1), 1-11. DOI: <https://doi.org/10.1128/jmbe.00146-23>
- Schneider, S., Wertli, M. M., Henzi, A., Hebeisen, M. & Brunner, F. (2024). Effect of an interdisciplinary inpatient program for patients with complex regional pain syndrome in reducing disease activity—a single-center prospective cohort study. *Pain Medicine*, 25(7), 459-467. <https://doi.org/10.1093/pm/pnae021>
- Sherren, K. (2005). Balancing the disciplines: a multidisciplinary perspective on sustainability curriculum content. *Australian Journal of Environmental Education*, 21. 97-106. DOI: <http://dx.doi.org/10.1017/S081406260000987>
- Smith, J. & Karr-Kidwell, P. (2000). The inter-

- disciplinary curriculum: A literary review and a manual for administrators and teachers. Retrieved from ERIC database. (ED443172).
- Verma, S. K. & Verma, R. K. (2024). The role of transdisciplinary education in addressing complex societal issues. *International Journal of Web of Multidisciplinary Studies*, 1(1), 33-39.
- Wilcox, B. & Kueffer, C. (2008). Transdisciplinarity in EcoHealth: status and future prospects. *EcoHealth*, 5(1), 1-3.
- Yıldırım, A. & Şimşek, H. (2016). *Qualitative research methods for the social sciences* (10.Baskı). Seckin Publishing.

Received: June 20, 2025

Revised: July 04, 2025

Accepted: December 28, 2025