VI SYMPOSIUM OF LOGISTICS AND QUALITY MANAGEMENT

Understand and develop academic logistic thinking: A contribution to metacognition

Comprensión y desarrollo del pensamiento logístico académico: Una contribución a la metacognición

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Abstract:

Logistics has established itself as a scientific discipline over the last 75 years and also has great economic importance for every society. Universities and other educational institutions train young academics who have to master the required interdisciplinarity and complexity, as well as recognize all tasks that arise, solve and implement them in a quality manner. This requires special logistical thinking. This makes it necessary to appropriately link general thinking techniques with the science-specific thinking of the individual disciplines involved. The paper aims to characterize academic logistic thinking and explain its usefulness in application to the country of Cuba.

The research questions are:

1. How should be described the science logistics?
2. How can general thinking, science specific thinking and connecting logistic thinking be combined?
3. How should be trained academic thinking in logistics at universities?

The research work is based on a systematic literature analysis of German-language specialist literature, supplemented by a survey of experts and on the explication of own expert knowledge in the cooperation in logistics of Magdeburg and Santa Clara. As a

result, a model of academic, logistical thinking will be developed and indications for the use of the findings in academic education and practical application will be given.
The value of the results lies in the contribution to the basic research of the scientific discipline of logistics on the one hand, and on the other hand, application examples from different logistics areas are given to illustrate the potential application and to facilitate a broad application.

Resumen:
La logística se ha consolidado como disciplina científica en los últimos 75 años y tiene una gran importancia económica para la sociedad. Las universidades, tecnológicos y otras instituciones educativas forman académicos que dominen la interdisciplinariedad y complejidad necesarias, así como reconocer todas las tareas que se plantean, resolverlas y ejecutarlas con calidad. Esto requiere un pensamiento logístico especial. Lo cual permite vincular adecuadamente las técnicas generales de pensamiento con el pensamiento específico de cada una de las disciplinas implicadas. El trabajo caracterizará el pensamiento logístico académico y explicará los beneficios en su aplicación en Cuba. Las preguntas de investigación:

1. ¿Cómo debe describirse la ciencia de la logística?
2. ¿Cómo se pueden unir el pensamiento general, el pensamiento específico de la ciencia y el pensamiento logístico de conexión?
3. ¿Cómo debe formarse el pensamiento académico en logística en las universidades?

La investigación se basa en un análisis bibliográfico sistemático de la literatura especializada alemana, complementado con encuestas a expertos y en la explicación de conocimientos propios especializados de muchos años, en la cooperación en logística entre Magdeburgo y Santa Clara. Como resultado, se desarrollará un modelo de pensamiento académico logístico y se darán indicaciones para el uso de los resultados en la formación académica y la aplicación práctica. El valor de los resultados radica; en la contribución a la investigación básica en la disciplina científica de la logística y se ofrecen ejemplos de aplicación de diversos ámbitos de la logística para ilustrar el potencial de aplicación y facilitar una amplia aplicación.

Keywords: Logistics; Supply Chain Management; Education; Training; Solution finding; Logistic Thinking

Palabras Claves: Logística; Gestión de la cadena de suministro; Educación; Formación, Búsqueda de soluciones; Pensamiento logístico

1. Introduction

The paper deals with fundamental questions of the science of logistics and makes a contribution to basic research. It builds on the publication by Glistau, Trojahn, Zadek, Coello Machado, Brinken (2023) & Glistau, Trojahn, Coello Machado, Börner (2021). The following issues were discussed in this first publication:

- Process model of the research work (image)
- Definitions of "logistics", "thinking" and "thinking cards"
- Characterization of the types of thinking in logistics using three approaches:
    - General ways of thinking, (number: 82)
    - Types of thought derived from logistics from the other individual sciences be used (more than 20)
    - Special "logistics mind cards"
- Draft and description of a thinking constellation
- Examples of categories related to logistics in tabular form.

In this paper addresses the following research questions: 1. How should be described the science logistics? It should be proven that logistics can rightly call itself a science. 2. How can general thinking, science specific thinking and connecting logistic thinking be combined? and 3. How should be trained academic thinking in logistics at universities? The paper aims to characterize academic logistic thinking and explain its usefulness in application to the country of Cuba.

2. Methodology

The research is based on the authors' many years of expertise in the relevant scientific field combined with a comprehensive literature review. In (Glistau et al., 2023) the scientific methodological approach is explained in detail. A systematic approach with

focal points was formulated for this purpose. In summary, the procedure is based on the preparation of your own expert knowledge (thinking, questioning, documentation), the evaluation of current academic education, research projects and trends as well as the analysis of existing publications in the German-speaking area, supplemented by creative, conceptual research work. In order to avoid a repetition of the publication of the procedure, reference is made here to (Glistau et al. 2023).

Methodical alternatives are: With regard to the type of literature analysis, the expansion of the language area, the addition of further databases, the modification and changed combination of search terms and specializations in the adjacent sciences. As an alternative to the literature analysis and the expert knowledge of the authors, other logistics experts (national, international) can be asked and their views can be compiled. In this sense, the results published in this paper initially represent an initial solution that should and must be discussed, supplemented, expanded and modified.

Degree of novelty: This research work builds on existing knowledge. The desired added value consists of reflecting on logistics as a science and academic logistical thinking as of the year 2023 and providing information for targeted academic training. The paper makes a contribution to basic research in the science of "logistics".

3. Results and Discussion

3.1 Result 1: Basic understanding of logistics as a science in 2023

First the question is answered: "How can be described the science logistics?"
First of all, the term "science": In (Bendel, 2019) it is defined: "Science aims to gain knowledge (research) and impart it (teaching), using recognized and valid methods and publishing or including results. In a certain sense, it is unconditional and open-ended."
In June 2011, the scientific advisory board of the German Logistics Association (BVL) in Germany developed a basic understanding of logistics as a scientific discipline in the form of a position paper (BVL, 2011). It says: "Logistics is an application-oriented scientific discipline. It analyzes and models economic systems based on the division of labor as flows of objects (mainly goods and people) in networks through time and space and provides recommendations for their design and implementation. The primary scientific questions of logistics thus relate to the configuration, organization, control or

regulation of these networks and flows with the aim of enabling progress in the balanced fulfillment of economic, ecological and social objectives." (BVL, 2011)

Technical criticism:

(1) There is agreement that logistics is an application-oriented scientific discipline. (Figure 1) Logistics includes basic research, applied basic research and applied research, which are characterized in Figure 1.

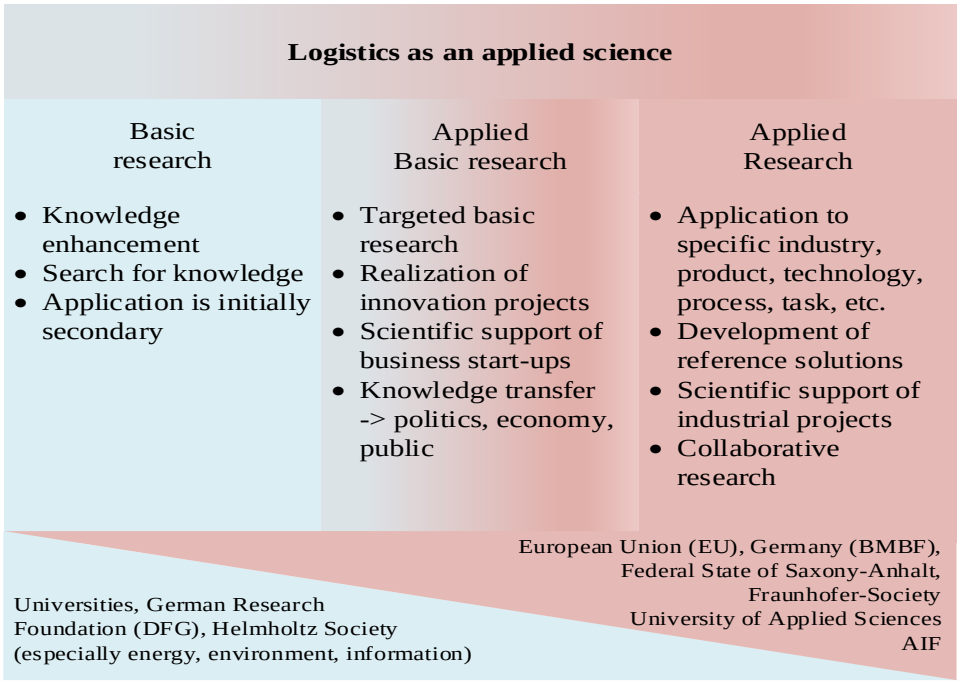

Figure 1. Logistics as an applied science (own elaboration)

(2) The definition unconsciously / consciously refers to material flows (people and goods). Information, finance and energy flows remain unmentioned.

(3) In addition to networks and flows, logistics also includes the consideration of business models, logistical objects, logistical systems and the logistical infrastructure.

(4) In addition to the balanced fulfillment of economic, ecological and social objectives, there is also a strong focus on, for example, the fulfillment of customer needs, compliance with laws and restrictions and the guarantee of resilience and security.

(5) In addition, all life cycle phases must be considered. At least the "operation" phase should be added to the definition.

The five points of criticism result in the recommendation of a new, updated definition (Figure 2) using the BVL definition.

Basic understanding of logistics as a science:

Logistics is an application-oriented scientific discipline.

Logistics analyses, models and calculates human-technology-organizational Systems as flows of objects in networks through time and space and supplies recommendations for action on their design, implementation and operation.

The flows considered include physical flows (material, people, goods) and related information, financial and energy flows.

The primary scientific questions of logistics relate to the configuration, organization, control or regulation as well as permanent improvement of these networks and flows with the claim, thereby progress in the balanced fulfillment of economic, ecological and social objectives (sustainability). The fulfillment of customer needs sets the objective and dynamic benchmark. Besides other criteria such as resilience, transparency and security also play an important role.

In addition to the flows, business models, logistical objects, logistical systems and logistic infrastructures in all phases of their life cycle individually and in connection considered.

Note: Own additions and changes have been highlighted in blue in the text!

Figure 2. New definition of logistics (Compare (BVL, 2011) and (own elaboration))

In addition to this basic understanding of logistics, innovations (e.g. digitization and networking) and social framework conditions (e.g. the Supply Chain Act (LKGS, 2023) significantly influence goals, options for action and solutions in logistics.

Ten Hompel characterizes the current status according to digitalization of logistics: "Logistics is on the threshold of the silicon economy. There is no alternative to the complete digitization of our supply chains and infrastructures with the help of artificial intelligence in order to make the mobility of people and goods sustainable and to achieve our climate goals Logistics 4.0 raised. (ten Hompel, 2021) In another paper (Delfmann, Kersten, Stölzle, ten Hompel & Schmidt, 2017) exemplary research questions relating to Logistics 4.0 are raised in this context.

Glistau, Coello Machado & Trojahn (2022) also lists and characterizes the effects of current trends in ICT, society and production on logistics. For the establishment of logistics as an applied science, the examination of relevant characteristics is necessary. (Cf. (BVL, 2011), (Jobst, 1968), (Diemer & König, 1991), (Helfrich, 2016), (Klaus, 2009) & (Mols, 2001)) Sciences primarily differ in their object of knowledge. (Thommen, 2018) Knowledge goals and the use of recognized research methods are also frequently mentioned. Important requirements for a science (Logistics) are shown graphically in Figure 3.

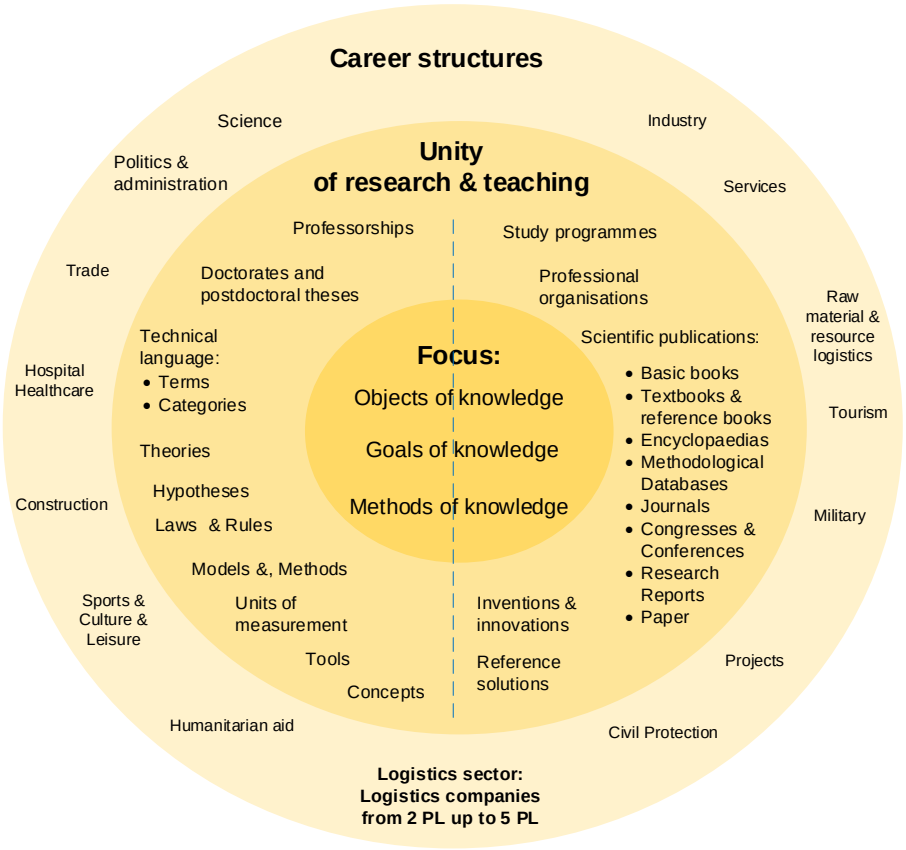

Figure 3. Requirements for a science related to logistics (own elaboration)

(1) Knowledge objects of logistics are:

- Flows in networks (BVL, 2011) = material, information, finance and energy flows and their synergistic linkage
- Logistics business models
- Life cycle of logistic objects (Material, goods, packaging, logistic aids)

- Life cycle of logistic systems including networks as human-technology-organizational systems
- Life cycle of logistic infrastructures
- Linking the design objects (business models, objects, processes, systems, infrastructure) to holistic logistics solutions
- Academic qualification and training of logisticians

(2) Knowledge goals of logistics are to discover, set up and formulate:

- Theories
- Hypotheses
- Laws
- Rules
- Sample solutions (Reference solutions)

with regard to the above-mentioned objects of knowledge, as well as the establishment of contents of academic teaching and their suitable forms of communication, learning, thinking, training and evaluation.

(3) Some important **research activities** in logistics are listed below as examples: (cf. (Lucke, 2022) and (own elaboration). These research activities are: perception & information, describe, invent, analyze, model, plan, optimize, improve, explain, carry out, evaluate, reflect, recognize and decide.

In addition, indicators of the presence of a science are the answers to the following questions (Table 2):

Table 2. Answer the questions "Does the science "Logistics" have" (own elaboration)

Aspect	Example
Own terms?	container, euro pallet, collaborative planning, cross docking, hub and spoke, freight, supply chain network
Own categories?	warehouse, means of transport, procurement logistics
Own theories?	service theory (queuing theory), theory of constraints (bottleneck theory) and congestion theory
Own hypotheses?	a) The mobility of the future in urban and rural areas requires and creates new logistics offers. This changes logistics flows, systems and infrastructure. b) The aging population generates a large number of new service offerings, from which logistics will benefit. c) AI has a wide range of applications in logistics (including SCM and SDN).
Own laws?	PANTA RHEI - everything flows. The chain is as strong as the weakest link. The bottleneck determines the performance. Logistic characteristics (Nyhuis & Wiendahl, 2012), Basic laws of production logistics (Nyhuis et al., 2012)

Continuation of Table 2. Answer the questions "Does the science "Logistics" have" [own elaboration]

Aspect	Example
Own rules?	The material flow dominates the information flow. Picking dominates the warehouse. The last mile is crucial. It is not allowed to consume more energy for logistics than can be generated by the energy production of the transported or stored energetic material.
Own models?	Business models 1PL to 5PL, Process chain, eEPC, Supply Chain Network, Warehousing model, Smart Logistics Zone
Own units?	tkm (tonne kilometers), pkm (passenger kilometers), GT (gross tonnage)
Own methods?	ConWip, KANBAN, Just-in-Time, Just-in-Sequence
Own tools?	SCM systems, Warehouse Management Systems, Tour & Route planning systems
Own concepts?	Forecasting & Replenishment, Lean Logistics, Six-Sigma, Load-oriented order release
A scientific community of its own?	**Germany:** Bundesvereinigung Logistik (BVL), Wissenschaftliche Gesellschaft Technische Logistik e.V. (WGTL) **Europe:** European Logistics Association (ELA) **Cuba:** Almacenes Universales S.A, Empresa de Logística (AZUMAT), Association national de economistas de Cuba (ANEC)
Own scientific teaching?	**Germany:** Professorships and courses at colleges and universities such as Logistics, Logistics Management, Supply Chain Management, Industrial Engineering in Logistics e.g. in Magdeburg, Dortmund, Berlin, Stuttgart, Hamburg, Bremen **Cuba:** Logistics professorships at Universidad Central "Marta Abreu" de Las Villas, Universidad de Cienfuegos Carlos Rafael Rodríguez, Universidad de Sancti Spiritus, Universidad de Matanzas, Universidad de Oriente, "Julio Antonio Mella", Universidad de Camagüey Ignacio Agramonte Loynaz, Universidad Tecnológica de La Habana, CUJAE, Universidad de Pinar del Río "Hermanos Saiz Montes de Oca"
Own scientific research institutes?	**Germany:** Fraunhofer-Institut für Verkehrs- und Infrastruktursysteme (IVI), Fraunhofer-Institut für Materialfluss und Logistik (IML), Fraunhofer-Center für Maritime Logistik und Dienstleistungen (CML), Abteilung Logistik- und Fabriksysteme am Fraunhofer IFF Magdeburg **Cuba:** Centro de Investigación y Desarrollo del Comercio Interior y Sociedad Cubana de Logística y Marketing de la ANEC, Laboratorio de Logística y Gestión de la Producción (LOGESPRO)
Own scientific textbooks and research literature?	**Germany:** Grundlagen der Logistik. Theorie und Praxis logistischer Systeme (Trojahn, Dittrich & Fricke, 2022), Logistik: Grundlagen - Strategien - Anwendungen (Gudehus, 2010), Logistiksysteme. Betriebswirtschaftliche Grundlagen (Pfohl, 2018), Integrierte Materialwirtschaft, Logistik, Beschaffung und Produktion: Supply Chain im Zeitalter der Digitalisierung (Wannenwetsch, 2021) **Cuba:** La Logística Moderna en la Empresa (Gómez Acosta, Acevedo Suárez & Colectivo de Autores, 2006), Logística del proceso de almacenamiento (Velázquez Albiol, 2005) Logística, Temas seleccionados. I y II (Mederos Cabrera, Daduna & Torres Gemeil, 2003), Logística y Gestión de la Calidad (Illes, Glistau & Coello Machado et al., 2012)
Own important research questions?	• Mobility in urban areas • Mobility in rural areas • Design of the last mile
Own encyclopedias?	Vahlens Großes Logistiklexikon (Bloech & Ihde, 1997), Logistiklexikon - Abkürzungen und Definitionen in der Logistik (Dück**,** 2001), 2.250 Begriffe nachschlagen, verstehen, anwenden (Bichler, Krohn, Philippi & Schneidereit, 2017), Gabler Lexikon Logistik: Management logistischer Netzwerke und Flüsse (Klaus, Krieger & Krupp, 2012)

Continuation of Table 2. Answer the questions "Does the science "Logistics" have" (own elaboration)

Aspect	Example
Own magazines?	DVZ – Deutsche Logistik-Zeitung, Logistik heute, Internationales Verkehrswesen
Own congresses?	**Germany:** Deutscher Logistik-Kongress, Handelslogistik Kongress, Logistik- und Mobilitätskongress, Zukunftskongress Logistik (Dortmunder Gespräche) **Europe:** CECOL 2024 Miskolc **Cuba:** Feria Internacional de Transporte y Logística (FITL 2022); VII Conferencia Científica Internacional Yayabo Ciencia. Universidad de Sancti Spiritus; III Convención Internacional Ciencia y conciencia 2023. Universidad-Sociedad y desarrollo sostenible. Universidad de Oriente; Conferencia Científica Internacional de Ingeniería Mecánica (COMEC)
Own career structures?	a) As a logistics service provider in the logistics industry (specialist and manager): "In Germany, around 2.8 million employees work in the logistics industry. Companies in this country are looking for highly committed and well-trained specialists and managers. The demand for academics is growing because the requirements are becoming ever greater, modern logistics applies strictly scientific principles and has become a decisive competitive factor for customer companies. The employees must… have analytical skills, business knowledge and extensive IT knowledge." (Karriere …, 2023) b) As a logistician in trade, industry, administration, other service facilities such as tourism, healthcare, maintenance, event management, etc. c) As a logistics specialist in universities, colleges, business academies, ministries and research institutions. d) As a logistician in humanitarian logistics, in the military, in project logistics and in disaster control
Own personalities of logistics?	Taiichi Ohno (!912-1990) the inventor of the Toyota production system with e.g. Kanban and Just-in-Time, Malcolm Mc Lean (1913-2001) the inventor of the container, Prof. Hans-Christian Pfohl (1942 -), one of the founders of scientific logistics research, Prof. Peer Witten (1945 -) one of the pioneers of internet trade and sustainability in logistics, Prof. Manuel Torres Gemeil (1944 - 2021) as a German-Cuban "bridge builder" in logistics. For more see e.g. the German "Logistics Hall of Fame". (LHoF, 2023)

The listing and the illustrative examples show that the requirements are met to justifiably describe logistics as an applied science.

3.2 Result 2: Logistical thinking and metacognition

Figure 4 makes it clear that the science of "logistics" uses interdisciplinary knowledge from many sciences and fields of knowledge and synergistically links them to solutions like a comb. At the same time, logistics also serves as an application area for the other sciences. As an example of the linking of e.g. "Quality Management and Logistics" see the reference book of the same name (Illes et al., 2012).

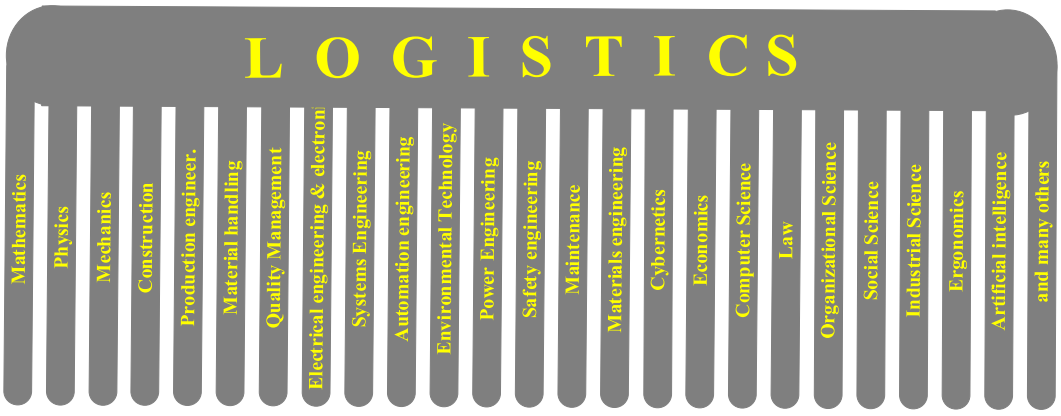

Figure 4. Logistics as interdisciplinary research and application area at the same time (own elaboration)

The interdisciplinarity influences and enriches the scientific work in logistics. In addition to bilateral constellations (Table 3), any multilateral constellations for solving scientific questions and tasks are also common and recommended.

Table 3. Examples of the bilateral linking of logistics with another science (excerpt)

Logistics	**Examples of bilateral linking of sciences**
+ Mathematics	Route planning, tour planning
+ Physics	Calculation of the centers of gravity of charges
+ Mechanics	Calculation of movements on conveyors
+ Construction	Construction of loading aids and packaging
+ Production technology	Production of packaging, production logistics
+ Material flow technology & traffic engineering	Planning of logistic centers
+ Quality management	Measurement of process capability
+ Electrical engineering & Electronics	Traffic control systems
…	…

The thesis is put forward below that each science is also characterized by a specific type of thinking, which is also what it is called, e.g. mathematical thinking or economic thinking. In addition to a large number of general ways of thinking that are available to all disciplines as a kind of basic repertoire, some types of thinking and models of thinking are particularly required and promoted by the individual scientific discipline. In order to solve typical mental tasks in logistics, our own mental models of the science of "logistics" are also developed and used. The research gap is to make this logistics

thinking explicit. Based on John H. Flavell (Flavell, 1979), this is referred to as "metacognition", "thinking about thinking itself" and is applied in this paper to the science of logistics: "This ability to control one's own thinking, to monitor it and to organize and correctly classify memories, perceptions and decisions, to reflect and evaluate them, can help people to make better decisions, to formulate achievable goals, but also to clearly recognize strengths and weaknesses." (Stangl, 1997)
When students begin their academic training, they start with their individual require-ements and knowledge of general ways of thinking. (Figure 5, below the yellow line).

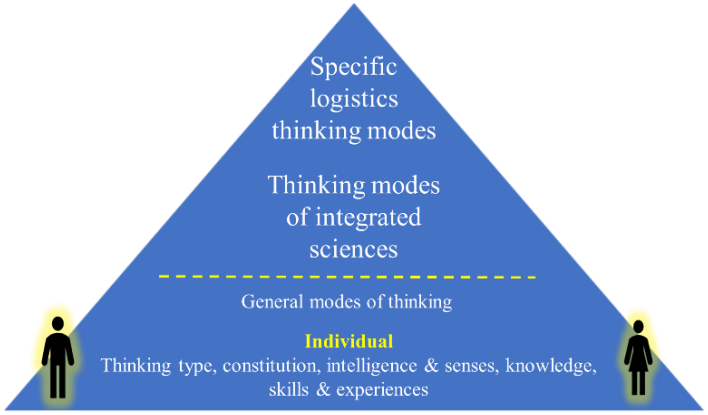

Figure 5. Academic logistical thinking by using thinking modes of integrated sciences and specific logistics thinking modes (own elaboration)

In (Glistau et al., 2023), for example, eighty-two logistics-relevant, general ways of thinking are listed as a useful basic repertoire. As part of the academic training in logistics, with the teaching of the individual sciences and the special logistics training, the students are also taught their thinking models and they are trained on typical tasks and problems. (Image 5, above the yellow line) This happens consciously or unconsciously. The concrete research question, resulting from this is: How can general thinking, science specific thinking and connecting logistic thinking be combined?

3.3 Result 3: Connection of the three groups of thinking in Logistics

Table 4 shows and list some results of the scientific work.

Table 4. Connect the parts: general, science-specific & logistics thinking (own elaboration & literature)

General thinking models Dorsch (1963), Denkarten (2023), Harrison & Bramson (2002) & Glistau et al. (2023)		
conscious, logical, dialogical, causal-logical, final-logical, analogical, lateral, discursive, argumentative, narrative, pictorial, analogue, associative, abstract, concrete, technological, ecological, biological, sustainable, logistical, technical, economic, informatic, mathematical, legal, sociological, academic, non-academic, pragmatic, empirical, heuristic, interdisciplinary, monodisciplinary, transdisciplinary, occidental, western, global, regional, operational, tactical, strategic, visionary, retrospective, present-orientated, forward-looking, Life cycle oriented (idea, development, construction, commissioning, use, dismantling/disposal), holistic, incomplete, rational, irrational, linear, causal, networked, control loop-based , case-by-case, complex, analytical, synthetic, inductive, deductive, discursive, vertical, lateral, quantitative, qualitative, reproductive, productive, idealistic, optimistic, pessimistic, realistic, theoretical, practical, flexible mindset, changing mindset, inflexible mindset, critical thinking		
Science specific thinking according Logistics (own elaboration)		
Science	**Main thinking content**	**Main thinking model**
Mathematics	calculable	analytical, logical, infer
Physics, Mechanics	conforms to natural law	movement & flow-oriented
Engineering in general: Construction, Production engineering, Traffic engineering, Material flow technology, Electrical engineering, Electronics, Systems Engineering, Automation Technology, Environmental Technology, Energy Technology, Safety Engineering, Maintenance, Quality Management, Materials technology	manufacturable, assemblable, disassemblable, automatable, environmentally compatible, energy compatible, safe, systemic, maintenance compatible, quality compatible, defect free, material sustainable	creative, analytical, critical, systemic, systematic, reflective, flexible, practical
Economics	economic model-based, time-related (visionary, strategic, tactical, operational, on-line, life cycle)	economical & competitive
Labour Science & Ergonomics	ergonomic	human-centred, ergonomic
Cybernetics	adjustable, self-controlled	control loop based, circuits
Informatics	programmable	algorithmic
Artificial intelligence	artificially supportable	artificial, mechanical
Organisational Sciences & PM	organizable	structural, process-oriented
Social science	socially just & sustainable	dialogical, communicative, quantitativ, qualitativ
Law	law-abiding	contextual, evaluiative
Pedagogy	learning, willing & able to learn	holistic, role based
Psychology	motivated, responsible	logical, creative
Logistics specific thinking (examples) compare (Glistau et al., 2023)		
Main thinking content	**Main thinking modes**	**Main thinking values**
Flow, **Value** chain, **Life cycle Customer, competition & service, Society**, **Smart Logistics Zone** (Schmidtke, Glistau & Behrendt, 2019) = Business Models, Logistical Object, Process, **System (Network**, Technology, Personnel, Organization) and Infrastructure, **Function**al optimization, **Technical-economic** thinking & Total cost thinking, **Organization**al task and thinking coordination, Project management and so on	holistic, interdisciplinary (but also mono- & transdisciplinary), integrative, time related = time factor & different levels of time: visionary, normative, strategic, operative, online & present & future-oriented & scenarios, complex, analytic, critical (includes: changing perspectives, asking questions, contextuali-zation, open discourse, listening, reading, writing as thinking) and so on	sustainable (efficient, ecological, social), quality-oriented, effective, safety & secure, fast, on time, holistic, resilient, digital & networked, transparent, innovative, integrative, weighing, flexible, Law compliant, simple realizable, adaptive, scalable, regional, international, global and so on

3.3 Academic training in logistical thinking

Table 5 illustrates how specifically the input side of logistical thinking can be trained.

Table 5: Training the senses for science "Logistics": Input side of logistic thinking (own elaboration)

Sense & training approach	**Academic training resources**	**Application in Cuba**
Sense of sight  Goal: "Learning to see logistically"	Static visualizations: • Texts • Data • Facts • Key figures • Photos • Drawings • Graphics • Charts Dynamic visualizations: • Aimations • Videos • Excursions • Digital twins Presentation and Lectures, • Lectures • Talks • Discussions • News • Colloquia • Guest lectures	• Use of visualization, presentation and communication of best practice solutions from around the world (television, videos). • Use of visualization, presentation and communication of actual solutions in Cuba. • Use of visualization, presentation and communication of trends. • Checklists of logistic solutions to "see and to "hear" logistic issues.
Sense of hearing  Goal: "Learning to hear logistically"		
Reflect sensory impressions  Goal: „Practice, evaluate and improve individual reflection"	Self-Reflection: • Evaluate (examine, analyze, criticize) • Summarize • Question Extraneous Reflection: • Team • Tutor, teacher Aktive Reflection • Dialogue • Discussions	• Answering questions about what you have seen and heard. • Giving an evaluation of what has been seen and heard. • Making lists of missing information. • Comparison with other people. • Professional argumentation.

For some more ideas according this topic "Training of Logistics thinking" compare (Glistau et al., 2023).

4. Conclusions

In the article, the three research questions formulated at the beginning were answered.

It has been demonstrated and proven that logistics is an accepted, applied science. There is also a great need for academically trained specialists and executives outside of the actual logistics sector. This demands and promotes high-quality academic training.

The thesis was put forward that the science of logistics requires and promotes special logistical thinking. In addition to general thinking models (Table 5), the thinking models of other relevant scientific disciplines (Table 5) are also used, this applies to mathematical and economic thinking, for example. To put it bluntly, Logistics is like a comb (handle) that synergistically uses and links the various individual scientific disciplines (teeth/tines) bi-, multilateral to holistic for the application area of transport, handling and storage.

The logistical thinking was characterized and hints were compiled for the academic training as to how, beginning with the training of the senses (learning to see and hear and reflecting logistically), thinking models of logistics can be made aware and trained.

This paper thus makes a contribution to metacognition and thus to basic research within the science "Logistics".

Further work concerns:

- Technical discussion and sharpening of the theory (national and international)
- Publication in other language areas (e.g. German, English, Spanish, Hungarian)
- Transfer from basic research theory to academic training (national and international)
- Development of supporting teaching materials
- Structuring of further training measures
- Use in applied basic and applied research.

The importance of the scientific work is that it summarizes 40 years of personal, scientific work in "Logistics" based on experience and creates an overview that can and must be further perfected.

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