

## **Interdisciplinary - A Historical Reflection**

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### **Abstract**

*Interdisciplinary team work combines the strengths of two or more disciplines with the aim of identifying problems, revealing associations, working out solutions to problems, and applying these. Such collaboration frequently yields new, unexpected, and possibly trail-blazing results. The remarkable aspects of interdisciplinary teams include the emerging insights and conclusions, which extend beyond the specialist's knowledge of his/her own speciality. These insights and conclusions are conceived and specified in interdisciplinary dialogue. Interdisciplinary work is increasingly used in the clinical sector to determine the optimal treatment regimen for the individual patient. In research it is used to find solutions to complex questions. It is also demanded in cross-disciplinary teaching. In this article we will describe the emergence of disciplines and highlight the historical context of interdisciplinary team work.*

**Key Words:** Interdisciplinary, Interdisciplinarity, Interdisciplinary team work, Disciplines, Multidisciplinary, A-disciplinary

### **1. Introduction**

Human beings, and particularly scientists, pursue a dividing and classifying mode of thought because of their basic and long-standing exposure to logic. This is comprehensible and logical, but by no means an essential or obligatory prerequisite to understand, interpret and comprehend associations. The individual disciplines represent such classifications, whose basic purpose is to achieve division, demarcation and identification. However, when the margins between disciplines are drawn too tightly or rigidly, on the one hand they become less manageable, and on the other hand the required cross-disciplinary team work is rendered more difficult and is even hindered. Based on this classification into different and apparently independent fields of knowledge, one is almost necessarily confronted with an increasing demand for cross-disciplinary and trans-border modes of generating knowledge. The call for multidisciplinary may therefore be interpreted as a compensation for advancing specialisation [1]. Interdisciplinary and multidisciplinary approaches are often used interchangeably, but these two concepts should be kept apart (Fig. 1 a-c).

Interdisciplinarity is currently used to answer complex questions. Identifying potential associations between disciplines may provide an interdisciplinary access when looking for solutions, but requires a meaningful and apparently necessary demarcation between the disciplines. Likewise, interdisciplinarity is demanded when one is confronted with subjects that cannot be clearly assigned to a single discipline. Linked knowledge can only arise if one pursues interdisciplinary dialogue [2].

Specialities differ in terms of concept, method, tools, processes and theories. However, it would be wrong to regard a discipline as a homogeneous and uniform body of knowledge – variations may be present in terms of concept, method, tools, processes and the developed theories. Interpretation and conclusion are also not fixed and constant entities within a discipline. That which is recognised and believed to be true, and is pursued as the truth, is based on the criteria established within the discipline to define the terms "true" and "false". Interdisciplinary exchange frequently compels one to critically review these internal values and modify them if necessary. However, first of all it would be necessary to take a closer look at the terms and the origin of disciplines in order to formulate a definition of the term "interdisciplinarity".

## 2. Discipline

The word discipline is derived from the Latin word *disciplina*; it refers to the instruction given to a student (also by way of a "disciple") by an older person, a mentor or a teacher. The word "discipline" also describes the difference in the levels of knowledge between the involved persons, who either have basic and/or specialised knowledge. The term "discipline" was used in the early Christian church to express the difference between "celestial" and "non-initiated" individuals. This shows that the term "discipline" is closely associated with knowledge and power. For a long time, knowledge remained the prerogative of a chosen few who could exert power because of their knowledge and did indeed do so. Power, dominance, authority, significance and influence have always been linked to specific knowledge. This link was exploited for several centuries in order to maintain a specific vision of the world and structures of power.

From the contemporary point of view, discipline and disciplines may be applied in two fields: first, as a measure to maintain order and control - for instance, among scholars or students as well as soldiers; and secondly to divide and classify knowledge. Linkage of these two meanings is still a crucial aspect of many educational systems: communicating knowledge and learning about specific and mutually divided fields of knowledge while ensuring "law and order".

The different pathways by which the interdisciplinary approach has developed may be explained by discipline-oriented division of knowledge: on the one hand we have its historical development - it originated in ancient Greece and initiated the academic dispute about the division and hierarchical classification of knowledge. This process advanced up to the present day and appears to be still in progress. The ancient hierarchical order - which assigned the highest rank to those fields of knowledge which could not be primarily classified under a specific discipline and were therefore non-disciplinary (or adisciplinary) - is taken as a rationale for disseminating or teaching such cross-disciplinary knowledge even today. On the other hand, the increasing specialisation of the disciplines compels one to adopt modes of thinking that permit cross-disciplinary interpretation by the establishment of links. The historical approach to explain interdisciplinarity is therefore attributable to the (allegedly perceived or factually tangible) loss of collective knowledge. The creation of a holistic approach on the basis of ethical and moral conceptual models is thus rendered possible not within individual disciplines, but only in a cross-disciplinary sense. The currently promoted tendency to focus on cross-disciplinary subjects may have arisen as a result of historical reminiscence, but also due to the emergence of new tasks, the identification of new developments, and the need to extend the scope of established disciplines [2].

Interdisciplinarity became necessary because of the emergence and rapid development of modern natural sciences. The increasing rejection of knowledge based on belief and the advancing orientation towards science-based conclusions supported this evolutionary process. The industrial revolution, accompanied by advancing technological developments and changes in agriculture (Agrarian Agitation) [2], are the activators of this evolution. University-based institutions reacted to these tendencies by the establishment of suitable disciplines. Therefore, these are not to be regarded as driving forces: research within the individual disciplines is not primarily pursued by university-based institutions. Rather, scientific societies are founded and then called upon to assume the task of conducting research.

This tendency has changed in the current university landscape: university research is regarded as a principal task of a university and the quality of the university or institute is closely linked to the production of the research facility. Obviously, one of the desired goals is to implement the conclusions derived from science in financial projects which can then be established as spin-offs in the international market. This task usually requires the cooperation of several disciplines. Therefore, the increasing number of disciplines and the consequent specialisations and sub-specialisations at universities are creating a demand for traditional dissemination of knowledge - a renaissance of the idealised concept of universal university education. Wilhelm von Humboldt refers to the general "formation of man", which should not be abandoned under any circumstances [2].

Due to this evolution, and particularly the rigid structure of the individual disciplines, many university facilities are experiencing difficulties in implementing the interdisciplinary approach. The traditional policy of clearly demarcated disciplines renders interdisciplinary team work difficult. Quite often the potential of interdisciplinarity is not realised in sufficient measure because of the fear of losing one's independence and significance/influence when working jointly on interdisciplinary projects.

The term "interdisciplinarity" emerged in the 1920s and was necessary because of the advancing specialisation within the disciplines and the consequent form of specific, discipline-oriented teaching. The purpose was to counteract the strong tendency to achieve a clear demarcation between individual teaching units.

### 3. Interdisciplinarity

The word "interdisciplinarity" is a combination of the word "discipline" and the prefix "inter". *Inter* is a prefix that expresses something that connects or communicates *International*, for instance, signifies the connection between nations that extends beyond national boundaries. Nevertheless, "inter" may also express something that simultaneously connects and divides - such as the word *interval* - a division of specific values which are yet linked to each other by the intervening gap. In this sense, the term *inter* in the word interdisciplinarity may be interpreted in two ways - on the one hand as a connecting element between two disciplines that are more or less distinctly apart, and on the other hand as a reference to the intervening space that always exists between disciplines [2]. Based on this point of view, interdisciplinary efforts may be positioned within the gaps between non - overlapping disciplines (Fig. 2).

However, *inter* must be clearly differentiated from other terms frequently and erroneously used as synonyms - such as multidisciplinary. *Multidisciplinarity* does not necessarily require a close interweaving of disciplines. It would suffice if the disciplines were working together, but still basically existed within their demarcations and bore their explicit and distinctive characteristics. Thus, a distinction must be made between interdisciplinarity and mere cooperation between disciplines. *Inter*, in connection with disciplines, expresses a linkage of various specialists with the aim of interweaving the underlying disciplines, transforming them, and founding new types of knowledge. In the extreme case, interdisciplinarity may give rise to new disciplines - although this is not the primary aim of interdisciplinary team work (Fig 3).

#### 3.1 Disciplinary or interdisciplinary, specialists or generalists

The purpose of individual disciplines is to classify knowledge. Such organisation of knowledge supports and focuses on the process of generating further knowledge. Even in ancient Greece, several subjects were arranged in a hierarchical fashion. The arrangement was based on the division of knowledge into *theoretical*, *practical* and *productive fields*. Simultaneously, a hierarchical order was established - theoretical subjects were given highest priority, whereas the productive disciplines were assigned to the lowest category. According to Aristotle, the theoretical disciplines included theology, mathematics and physics - in descending order of importance. Ethics and politics were termed practical disciplines. Productive disciplines included art, poetry and technology. The basic debate as to whether theoretical subjects should be considered superior to practical subjects started because of the cross-disciplinary dimension of some subjects. These subjects were termed *adisciplinary* and were therefore universal. Qualitative values such as applicable and/or necessary were not required of theoretical knowledge. Thus, philosophy developed as the highest and universal form of disciplines, which combined or joined the other branches of the disciplines. These considerations are still expressed in debates concerning whether a system of generalists or specialists should be given preference. The division or compartmentalisation of knowledge into various disciplines has persisted to the present day. A reversal of this system is not anticipated to occur even in the future. However, advancing specialisation leads to gaps in the level of comprehension between individual disciplines and eventually gives rise to the demand for interdisciplinarity - in order to close the gaps between disciplines.

At universities, whose very designation expresses their claim to omniscience and generalisation, a transformation occurred in the late Middle Ages - a shift occurred from cross-disciplinary general study to discipline-oriented study. Medicine, theology and law were established at various European universities. This was due to economic and political factors as well as internal developments at the university-based institutions. However, the principle of the basic study of the so-called free arts persisted for a long time - consisting of the *trivium* which comprised logic, grammar and rhetoric, and the *quadrivium* which encompassed arithmetic, geometry, astronomy and music. Conclusions about the natural sciences drawn by Copernicus, Kepler, Galileo, Newton and others transformed the culture of knowledge and finally led to a new vision of the world, which differed markedly from the one existing prior to this time: Nature could be explained by a few natural laws, based on the conclusions drawn in a few disciplines such as mathematics and physics - and not those generated by philosophy or theology.

On the contrary, philosophical or theological models which tried to explain the newly formulated natural laws and confine them in terms of their dimensions failed to do so. Modern science was thus founded - which is marked by the identification of a problem, including the formulation of a question (hypothesis), and the conduct of suitable experiments using new measuring instruments like the microscope or the telescope. From this time on, the task of a scientific discipline was increasingly viewed as the establishment of laws concerning phenomena, observations, and possible associations within one's own field of research. The enormous advancement of knowledge and insights in modern science can be traced back to a highly concentrated and targeted search for conclusions within the individual disciplines. The evolution of the disciplines was therefore promoted by the explicit demarcation of these as opposed to other disciplines, and has apparently not been hindered in any way.

### 3.2 Modified hierarchies of disciplines

Several attempts were made to adjust the disciplines to the developments, reorganise them, and introduce a modified hierarchy. For instance, René Descartes adhered to the superiority of philosophy. Philosophy, he said, was the tree whose roots were formed by metaphysics, the trunk formed by physics, and branches were formed by the remaining disciplines [3]. Neglecting a wide and comprehensive education in favour of the transfer of specialised knowledge was also criticised [4]. Knowledge should not merely be "discovered"; rather it should be "constructed" or "created". The classical hierarchical order of the disciplines was discarded; the humanities (philosophy, history, etc.) were ranked superior to the natural sciences (mathematics, physics, etc.). This attempt to achieve a hierarchy shows that two types of knowledge and teaching exist. On the one hand we have the target-oriented model of natural sciences, which are simpler to document, progress more rapidly because of their manageable and limited fields of knowledge, and are able to develop and communicate *useful* (i.e. applicable) data. On the other hand we have the cross-disciplinary studies of the humanities with the goal of creating and teaching neutral, generally applicable, and objective knowledge. To this day the term Doctor of Philosophy (Ph.D.) has survived in the world of academic specialisation - a high academic degree that is supposed to be achieved by performing a scientific project, independent of one's own specialisation, and preferably in cross-disciplinary fashion [5].

The hierarchical order of the different disciplines was a subject that also occupied Emanuel Kant's attention [6]. Kant made a distinction between higher faculties such as theology, law and medicine, and lower faculties such as philosophy. Kant established the difference between higher and lower faculties by the existence of a higher authority. The Bible was the authority in theology, the laws were the authority in jurisprudence, and so on. Philosophy, however, was a lower discipline, did not require any superior authority, and was therefore not dependent on such established authority as a standard. Thus, for Kant philosophy remained the ideal form of universal knowledge within the realm of advancing specialisation. During his inaugural lecture at the University of Jena in 1789 Friedrich Schiller [7] referred to the distinction between education and training. Education is the transfer of extensive and broad-based knowledge while training prepares a person for specific tasks. Despite this maintenance of the significance of universal knowledge, specialisation of the disciplines was pursued with fervour and is still pursued today. One of the reasons for specialisation was the fact that a person could progress more rapidly and easily within a discipline. A career can be planned more easily and pursued more rapidly within a clearly delineated field that is manageable in terms of its complexity. Therefore, the evolution of disciplines may also be viewed as the outcome of the increasing numbers of scientists and academic staff members at university institutions. This development is also observed in the educational sector, especially in the replacement of philosophical and comprehensive thinkers (academics) by science-oriented teachers who communicate the practical application of knowledge within closely defined disciplines. Friedrich Nietzsche was critical of this development. The fact that the individual disciplines demonstrated an increasing lack of interest in the knowledge generated in other fields was the focus of his criticism. According to Nietzsche, one was called upon to combat the deficiency of exchange and the tendency to view teaching and research purely as a means of ascending the "job ladder" - combined with a rising degree of bureaucracy [8].

While it was common in earlier times to distinguish between educated and uneducated persons, today a facet has been added to this contrast by the philosopher Ortega y Gasset. Ortega describes the educated ignoramus who is marked by bigotry and a capricious attitude towards knowledge as follows: he avoids, misjudges or ridicules knowledge entering from the outside. Ortega goes as far as to describe this state of development as a new type of dilettantism [9].

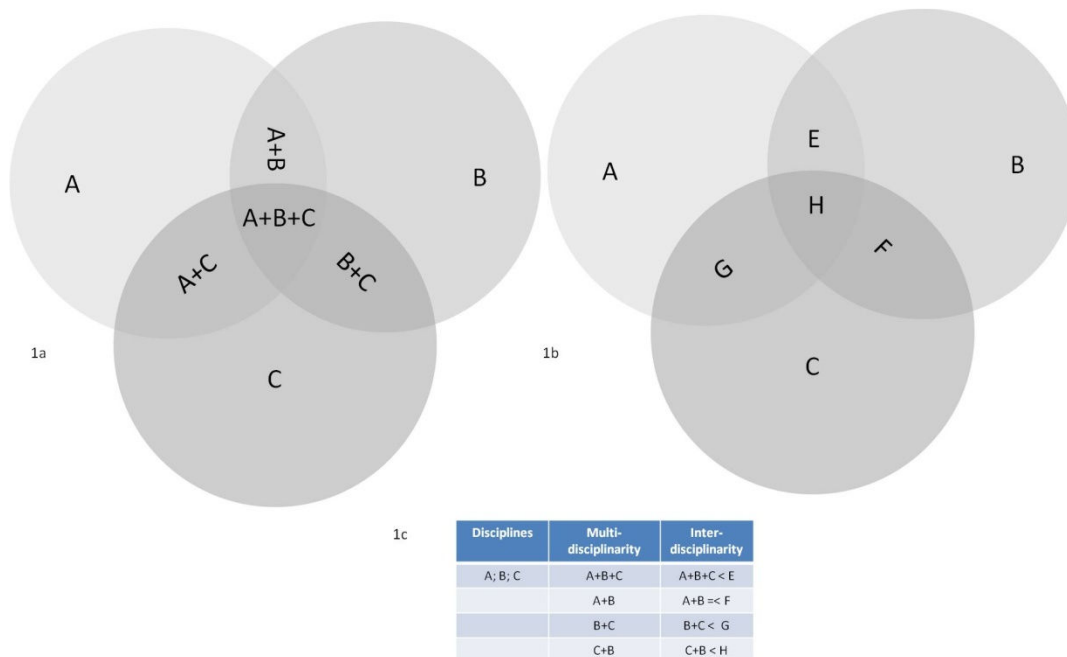
#### 4. Conclusion

Despite all these warning and cautioning voices, the individual disciplines prevail. The success of this evolution is attributable to the external view and attention on the part of the state and the economy – in addition to the previously mentioned phenomena. The evolution of knowledge, especially knowledge that can be applied immediately and in the mid-term, is regarded as an essential and supporting foundation of the modern governmental structure and is one of the primary guarantees of economic and financial development. In doing so, the fact that the disciplines are increasingly presenting themselves in a repetitive and self-reflective fashion is accepted. In the early 1960s, Clark [10] complained about the fact that several disciplines, once established, believe their primary task is to isolate and defend themselves, and argue in favour of their own exclusive right to exist. Even T. Becher [11] is critical of this development: disciplines drift apart and take less and less notice of each other. Instead, a culture of exchange and discussion between disciplines should prevail in order to permit new and cross-disciplinary thought, neither based on exclusivity nor on the exclusion of others.

Interdisciplinarity is not a means of preventing the separation of individual disciplines. Rather, the inevitable gaps that arise between the disciplines must be bridged. However, interdisciplinarity is not the only form of cross-disciplinary team work. Not every scientists or academic has an aptitude for interdisciplinary team work. Persons who are interested in it tend to think divergently - in contrast to the convergent mode of thought pursued by specialists. Members of interdisciplinary teams must possess differentiating, relativising and synthetising characteristics to a greater degree than others. Experts who think in disciplinary fashion tend to believe they can find the solution to a problem on the basis of their expertise and from their own viewpoint - even when working within an interdisciplinary team. The interdisciplinary scientific approach, on the other hand, would consist of providing the required contribution that one can offer as a specialist in order to resolve the problem.

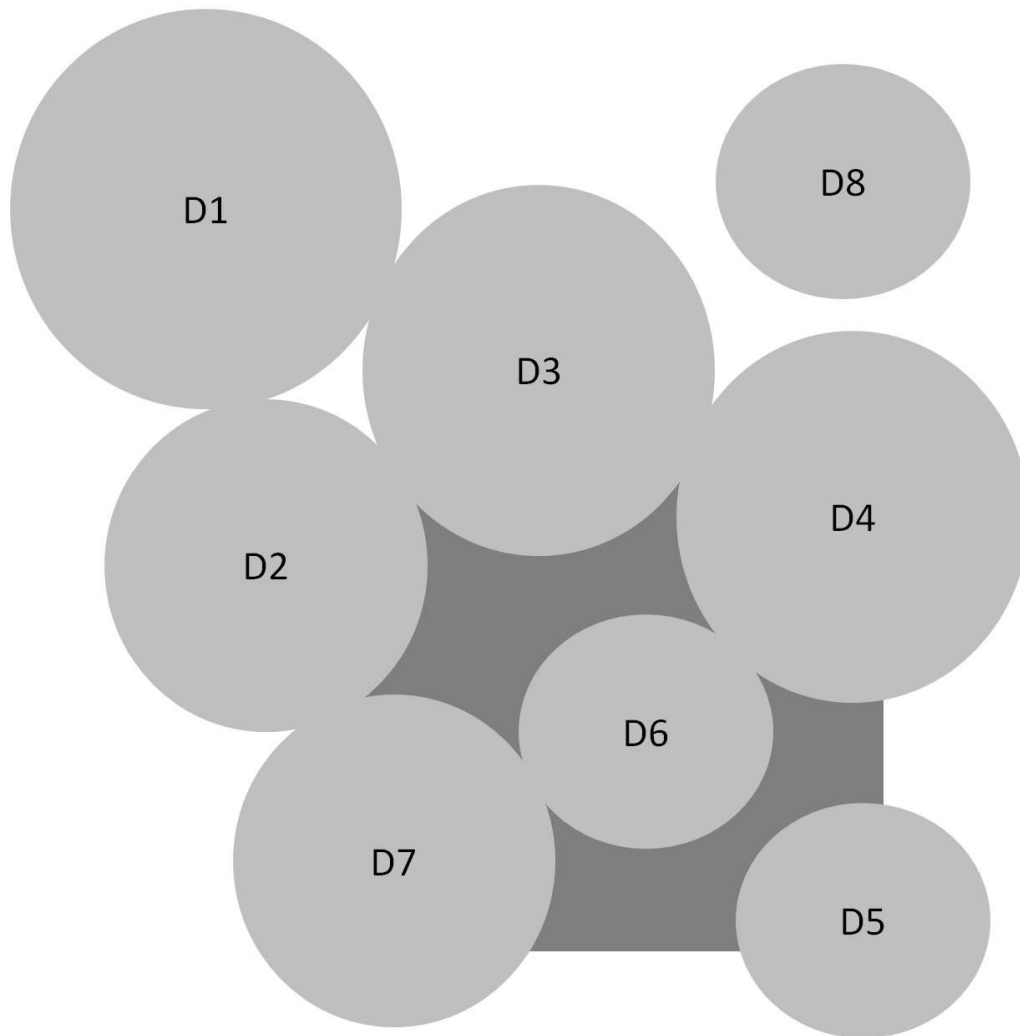
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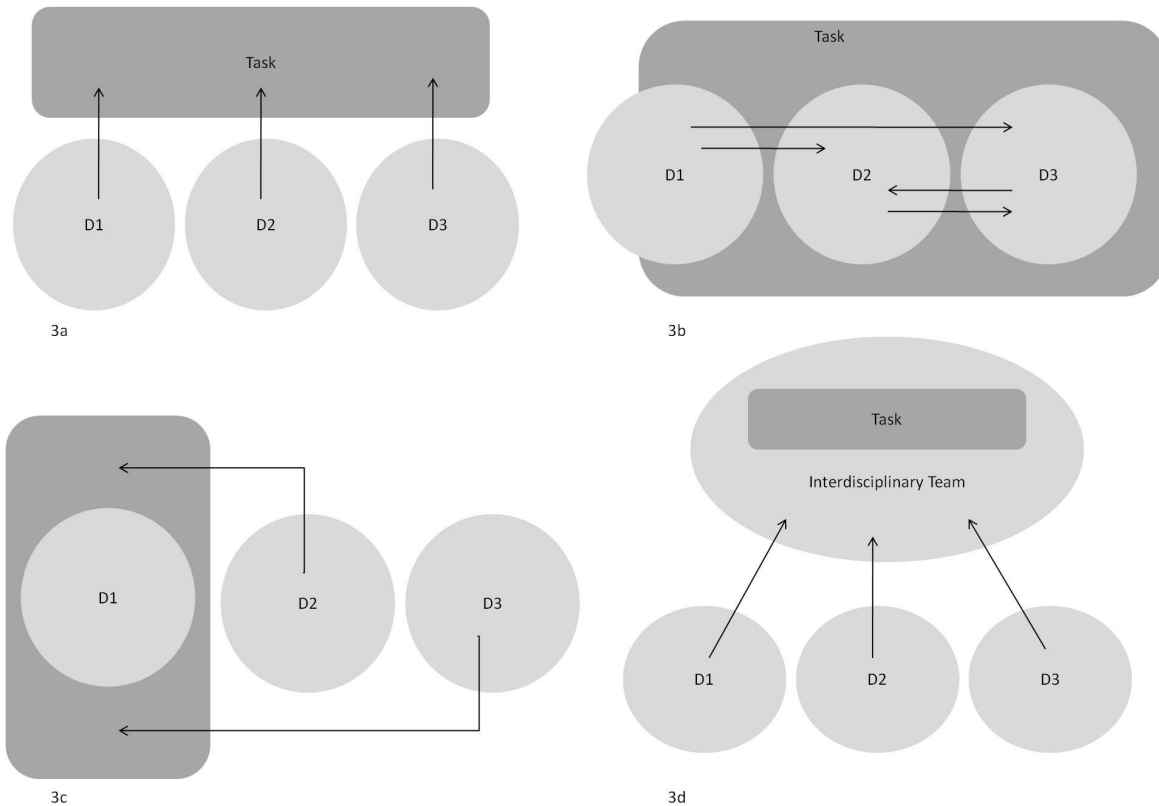


**Fig 1: Multidisciplinarity versus Interdisciplinarity:** 1a: Traditional concepts of interdisciplinarity are often visualized by the overlap of different disciplines. The overlapping areas are called interdisciplinarity, but there is not necessarily a need for changes within the disciplines. But without changes within the disciplines, a major requirement of interdisciplinarity is not fulfilled. Disciplines might remain in their traditional way of thinking and problem solving.

Such scenarios should be called multidisciplinary. 1b: Authentic interdisciplinary work means, that overlapping areas indicate changed and adapted concept of each discipline. 1c: Disciplines can be joint or merged in different ways. Interdisciplinarity leads to new concepts and new knowledge.



**Fig 2: A model of interdisciplinarity without overlapping disciplines:** Crossing borders of disciplines does not necessarily indicate an intrusion into another discipline. The space within disciplines, especially if disciplines are isolated from each other and without tangible borders (D6), may serve as the base for interdisciplinary concepts.



**Fig 3: Teams and collaboration:** Different schemes of teamwork across boundaries of disciplines, depending on the principle approach to a problem. The way of posing a problem leads necessarily to different structures of teams. 3a: pure multidisciplinary; 3b: Pluridisciplinary 3c: Cross-disciplinary 3d: Pure Interdisciplinarity (Adapted from [6]).

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