

## Higher-order Thinking Skills and Metaphor

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### Abstract:

Higher-order thinking skills (HOTS) are of utmost importance for students to succeed in school/ educational institutions and to prepare them for the labour market as well as for contemporary life in general. We argue for how metaphor is relevant for higher-order thinking skills in general and (knowledge) transfer, critical thinking and problem-solving in particular – because metaphor is a central matter of thought influencing perception, thinking and action. A focus by teachers and students on the cognitive potentials of metaphor, can enhance the students higher-order thinking skills and learning.

### Keywords:

Higher-order thinking skills, cognitive metaphor, transfer, critical thinking, problem-solving.

## **Introduction**

The 21<sup>st</sup> century skills encompass a broad range of skills related to higher-order thinking. Since the turn of the century international organizations, politicians, policymakers, school reformers, educators and teachers, and many others, have argued that 21<sup>st</sup> century skills are needed for students to succeed in school and prepare them for the labour market and contemporary life in general (Ball and Garton 2005; Heong et. al. 2012; Lord and Baviskar 2007; Berthelsen 2016). The world is ever-changing and ever challenging; due to, for example, the rapid and constant development of technological possibilities and the endless flow of information, innovation-driven and knowledge-based economies as well as changes in community commitments; and these changes and the challenges demand higher-order thinking skills. The focus on higher-order thinking skills, in particular spreading from the United States, has led to educational and teaching reforms worldwide with new strategies, curricula, goals, and functions for formal education; and where the prioritizing of higher-order thinking skills also involves the belief that these skills can be applied within all subject areas and throughout a student's life. Across various disciplines (e.g., philosophy, psychology, and social studies) attempts have been made to delineate higher-order thinking skills in contrast to what is understood as traditional canon-based learning concerning facts and figures and lower-order thinking skills, for example, mere recall and memorization of information (in relation to, for example, the taxonomy of Bloom et. al. 1956; see also Zohar and Dori 2003: 147). There does not exist a clear consensus on how to define higher-order thinking and the skills that it involves. However, many definitions, despite of different frameworks and terminology, point towards that higher-order thinking concerns cognitive activities which tend to be complex, creative and manipulate information in relation to new situations or contexts (Newman 1990; Anderson and

Krathwohl 2001; Brookhart 2010); furthermore, thinking skills such as transfer, critical thinking and problem-solving are often viewed as central. It has long been acknowledged that some metaphors can be complex and creative and have a cognitive content; or that these metaphors can convey novel meaning by bridging the gap between what is known and the unknown. It therefore seems safe to assume that metaphorical thinking is a mechanism underlying and influencing parts of higher-order thinking; and we believe, more specifically, that metaphorical thinking, indeed, also can play a cognitive role in relation to transfer, critical thinking and problem-solving. Extensive research has been made in relation to metaphor in education, teaching and learning, for example, concerning the cognitive and critical potentials of metaphors (Littlemore 2016); however, studies about metaphor with an explicit reference to high-order thinking skills, including transfer, critical thinking and problem-solving, are still rather few. As a part of higher-order thinking we should expect that metaphorical thinking can be taught/learned; and, this is, of course, also the case.

Metaphorical thinking invents the possibility of exploring similarities between a student's earlier understanding of and experience with a phenomenon and a new and hitherto unknown experience; and this possibility of exploring similarities (for example between different conceptual domains) is central, we believe, for the student learning both (knowledge) transfer, critical thinking and problem-solving.

## **Method**

In the following we will, firstly, make some comments concerning our considerations on the possible importance of metaphor in relation to education and higher-order thinking skills accentuating the special cognitive function of metaphor. Secondly, we will look into how metaphor works as a process of thinking. Thirdly, and finally, we will try to couple metaphor with the three higher-order thinking skills transfer, critical thinking and problem-solving. We will, in particular,

draw on theoretical insights from Lakoff and Johnson, but also Umberto Eco, Max Black as well as Charles Sanders Peirce.

### **Discussion on metaphor as relevant for higher-order thinking skills**

Why should metaphor matter in education and in higher-order thinking? Well, to begin with has it become more and more clear, with the extensive research on metaphor since the late 1970's till today (and there seems to be no end in sight to this research), that metaphor is not merely an embellishment or ornamentation to be found primarily in poetry and rhetorical discourse; on the contrary, is metaphor a natural part of language, everyday speech, and, in fact, any type of discourse. As Eco wrote in *The Role of Reader* (1979): "The majority of our messages, in everyday life or academic philosophy, are lined with metaphors." (Eco 1979: 69). With their book *The Poetics of Growth: Figurative Language in Psychology, Psychotherapy, and Education* (1977) Pollio et.al. reported on research into metaphor and common discourse texts and how they had discovered that a speaker of English, on average per week, would utter an impressive 3,000 novel metaphors and 7,000 idioms; hence, Pollio and his colleagues concluded that metaphor cannot simply concern an extension of literary language use or metaphor does not only say what otherwise can be said (see also Danesi 2006: 186). Thereby, is metaphor not just a substitutive (or even deviant) element of language; rather, has metaphor an additive potential, and with affinity, is the door furthermore opened up for that metaphor can be understood as an expressive mode having a cognitive function. And, this is exactly also the conclusion coming from the overwhelming amount of research on metaphor which now is known under the name "conceptual metaphor theory" – developed by Lakoff and Johnson (1980); Lakoff (1987); Lakoff and Turner (1989); Steen (1994) and Kövecses (2010) to mention some of the most prominent contributors to conceptual metaphor theory. According to conceptual metaphor theory is metaphor not only a matter of speech and language (e.g., words or sentences); instead, is metaphor constitutively involved in thought and processes of

thinking; or formulated differently does metaphor permeate and affect perception, feeling, action, and thinking and, in sum, the way in which reality is conceived. This is because, as Lakoff and Johnson said in their seminal work *Metaphors We Live By*, the conceptual system itself is metaphorical in nature:

Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature...the way we think, what we experience, and what we do every day is very much a matter of metaphor (Lakoff and Johnson 1980: 3)

As a consequence, does metaphor both enable and constraint conceptualizations, for example, when the ill-structured is structured or the abstract is concretized through metaphor (Lakoff and Johnson 1980: 177). Lakoff and Johnson explained the relationship between metaphor and the conceptual system as follows:

...human thought processes are largely metaphorical. This is what we mean when we say that the human conceptual system is metaphorically structured and defined. Metaphors as linguistic expressions are possible precisely because there are metaphors in a person's conceptual system. (Lakoff and Johnson 1980: 6)

But if the conceptual system is structured in terms of metaphor, then is the metaphorical use of language a derivation of the function of the conceptual system; this is a pivotal point because education, teaching and learning are, naturally, based on the same conceptual system. Or, to put it more strongly, education, teaching, and learning must also be permeated by the use of metaphors and metaphorical thinking. This is, of course, also the case as reflected in a variety of ways at both theoretical and practical levels. Metaphors are, for example, constitutive of education policies and strategies (a school is for example on a market as an “educational offer”), teaching processes (involving orchestrating, conditioning, (knowledge) construction), didactical approaches (are

roleplays or dramas), teachers thinking about themselves as teachers (as a captain, entertainer, facilitator), and the way the student learns (as a sponge, filter, partner, fragile plant) (Botha 2009: 433). And, furthermore, is extensive research, including case studies and experiments, indeed, accentuating how teachers and educators do think via metaphors or these become “vehicles of thought” (Chen 2003; Nikitina and Furuoka 2008; Mahlios et.al. 2010; Bradley and Brummenlen 2012). In her article “Metaphor use in educational contexts” (2016) Littlemore succinctly summed up how wide-ranging the findings and research is concerning the importance of metaphor in educational contexts as follows:

Evidence for the key role played by metaphor in educational contexts can be found in both written and spoken language, as well as in other forms of expression, such as images and gesture. It can be found in child and adult education, in first and additional language contexts, and in both formal and informal settings. A wide variety of research methods have been employed to investigate the use of metaphor in educational contexts. These range from discourse analysis, through corpus-based studies to more experimental studies designed to explore the extent to which metaphor presents a problem or studies involving different groups of students being shown doctored texts and asked to draw conclusions from them. Metaphor in educational discourse has also been studied from a multimodal perspective. (Littlemore 2016: 1)

Metaphors, for example, influence what teachers and educators do in the classrooms (qua conceptualizations), and this sometimes includes a systematic didactic (deliberate) use of metaphor (Wormeli 2009), which even can involve a heuristic function leading to creative discoveries in the student’s process of learning (Todor 2016). The last-mentioned point naturally brings us back to higher-order thinking skills and teaching these skills to students. Yet, the question is, of course, how can we relate metaphor to higher-order thinking skills in the first place? As indicated in the

introduction there does not seem to exist an agreed definition on higher-order thinking; to say that there are as many definitions of higher-order thinking as there are different educational programs with the goal of fostering student's higher-order thinking skills, will surely be an exaggeration – but the number of definitions is still staggering. However, in her paper “Education and Learning to Think” (1987) Resnick put forth a broad (but not vague) characterization of higher-order thinking which seems, even though it was formulated more than thirty years ago, to bring together key features of many definitions into a coherent list (also concerning more recent definitions). Hence, according to Resnick some key features of higher-order thinking can be listed as follows (we mention the features which we believe are of particular relevance to metaphor in relation to higher-order thinking): It is non-algorithmic, it tends to be complex, it often yields multiple solutions, it involves uncertainty, self-regulation, and it is effortful (Resnick 1987: 3). Such features also seem to be key features of at least some processes of metaphorical thinking – some processes of metaphorical thinking certainly not all; because even though all metaphors probably are the result of processes which are nonalgorithmic, not all metaphors are complex and yield multiple interpretative solutions, and, therefore, do not involve uncertainty and effortful thinking. These non-complex metaphors we can call, with Eco, “closed metaphors”; they are scarcely cognitive, because as he wrote, such metaphors are: “saying something that is already known.” (Eco 1984: 121). Closed metaphors are highly conventionalized and, therefore, they limit and control the thinking process. In his article “Educating Openness” (2018) Campell, also reading Eco, put this point very precisely:

[A] closed metaphor is a metaphor that limits and reduces our thinking by not allowing us to explore and make new connections to our existing knowledge structures. The closed metaphor rather forces an established course upon our thinking, controlling, and standardizing meaning-making. (Campell 2018: 321)

Hence, closed metaphors are not of (much) relevance in relation to higher-order thinking; however, we do believe that it is still important to mention the closed metaphors in contrast to the metaphors which, to a lesser or greater degree, are characterized by all the key features concerning higher-order thinking as listed by Resnick. This type of metaphor, which we will call “cognitive metaphor” (with a reference to Lakoff and Johnson), is, first and foremost, characterized by that its underlying process of thinking involves the transfer of a (well-)known concept to an unknown situation or context. Casakin characterized this process well in his article “Metaphorical Thinking and Design Expertise: A Perspective for Design Education” (2011) as follows:

In order to make the unknown clear, a reference to what is known and understood should be made. This is precisely the fundamental nature of metaphor - an atypical juxtaposition of the familiar with the unfamiliar. In essence, metaphors help to reason about a situation from a variety of viewpoints, which may promote the formation of new concepts. (Casakin 2011: 32)

And, this is indeed, we believe, what brings into being and involves the key features of higher-order thinking both from the perspective of the metaphor-maker and concerning the process of metaphor-interpretation – probably mostly pronounced in a context of learning or problem-solving with a deliberate and self-regulated focus (remembering that metaphorical thinking mostly takes place when we are not aware of it). What Casakin called “an atypical juxtaposition” in metaphor exactly concerns the need for the discovery of a relation of similarity between the familiar and the unfamiliar. Hence, what in the beginning seems “atypical and juxtaposed” turns out to be meaningful. The discovery of meaningful relations between the familiar and the unfamiliar is where we find the potential for learning in relation to metaphor. Because, as Petrilli succinctly explained in her article “Meaning, metaphor, and interpretation: Modelling new worlds” (2006) metaphor:

...enhances the processes of understanding, interpretation, and invention thanks to the identification of relations that have not been observed previously or to the creation of



relations that are completely new in the sign network. Metaphorization...is structural to the process of meaning production and to the acquisition of knowledge. (Petrilli 2006: 79)

What relations of similarity will be discovered by the metaphor-maker or interpreter (both understood here as learners) depend not only on the previous knowledge or the collateral experience (see also Sørensen, Thellefsen and Thellefsen 2014) and of the metaphor-maker or interpreter with the familiar object or situation; nor does it simply rely on the verbal mechanism which calls attention to the relation of similarity as well as the linguistic co- and context. Rather, is it reality which puts constraints on what, in the first place, can be discovered as relations of similarity. Even though Haley (1988) was studying poetic metaphor in his book *The Semeiosis of Poetic Metaphor* we believe that his point on similarity is valid for metaphor no matter in which discourse (or semiotic system) it occurs. Hence, Haley wrote:

The similarity takes its distinctive nature...from the nature of real possibility, not from the merely verbal mechanism which calls attention to it. While the...metaphorical perception is highly imaginative, the perceived similarity is not imaginary. It is real...it is real before it “exists” in the mind of the reader, in the linguistic construct of metaphor, or in the mind of the [metaphor-maker]...it implies that not just any fancy that brings together two contrary objects in an anomalous connection, however imaginative, can qualify as...metaphor. (Haley 1988: 47)

Which is not the same as saying that there cannot be, for the metaphor-maker and interpreter, multiple interpretative solutions in order to discover/interpret the relations of similarity – relative to the complexity (including the novelty) of the metaphor. And, with the degree of complexity (and novelty) comes, furthermore, a certain degree of uncertainty and effortful thinking on behalf of the metaphor-maker or interpreter. This is because cognitive metaphor, we think, can be related to what Peirce called abduction, namely, the only type of inference, according to him, which can convey

new ideas or present answers to new problems. With abduction, however, is the conclusion presented only conjecturally, or it is akin to guessing, saying that something may be – as when, we will add, the familiar, for example, is juxtaposed with the unknown in a (possible) cognitive metaphor. Hence, we believe, that cognitive metaphor, to a certain degree, involves an “abductive effort” (sometimes even a great effort) or a reach between different conceptual domains. One of Peirce’s descriptions of abduction, indeed, seems to open up for the interpretation that there is a possible relation between metaphor and abduction (see also Liszka 1996: 69; Sørensen, Thellefsen and Moth 2007; Sørensen and Thellefsen 2012). Charles Peirce wrote as follows:

A well-recognized kind of object, M, has for its ordinary predicates,

P1, P2, P3, indistinctly recognized.

The suggesting object S, has the same predicates.

Hence, S is of the kind of M. (CP 8.64; 1891)<sup>1</sup>

A cognitive metaphor also suggests that two things, from a certain perspective, are of the same kind and that due to a relation of similarity (concerning predicates). And an abduction, with Peirce, is exactly, qua a relation of similarity, the movement from the familiar to the unknown, which then, tentatively, becomes explained as a “may-be”. Abduction begins with, Peirce said, an anomalous situation, a surprise, or something which causes doubt; and sometimes it is, indeed, we will add, a cognitive metaphor which will explain the anomalous, the surprising or that which causes doubt. But the abductive effort which the cognitive metaphor requires – relative to how anomalous and surprising the situation is and the experience and knowledge of the metaphor-maker or the interpreter – will always involve a degree of effortful thinking, indeed, going from the familiar to the unknown. And because the cognitive metaphor, qua abduction, concerns a “may-be”, it also involves a degree of uncertainty – maybe there are worm-holes, electron clouds, and, maybe

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<sup>1</sup> We refer to The Collected Papers of Charles Sanders Peirce as follows: CP, volume followed by paragraph and year.  
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(nuclear) atoms are miniature solar system? This concerns, of course, the degree of complexity of the cognitive metaphor, understood from the perspective of the relation(s) of similarity which the metaphor introduces; because as Eco accentuated in *Semiotics and the Philosophy of Language* (1984) what is already known is what language or another semiotic system have “registered”, for example, about the spatial locations of bound electrons (electron clouds), and, therefore, as he said: “...it is possible to recognize a metaphor that demands unprecedented interpretative operations, and the identification of [similarities] not yet identified.” (Eco 1984: 122). The three metaphors mentioned here, of course, all stem from scientific discourse and potential ground breaking discoveries when they first were formulated and began to be interpreted and stimulate experiments and further hypotheses (see also Sørensen, Thellefsen and Dewi 2021). Yet, we do think that the cognitive metaphor always, qua definition, is complex at least to a certain degree; cognitive metaphor involves going from the familiar to unfamiliar in a juxtaposition; furthermore, the cognitive metaphor often yields multiple interpretative solutions because it concerns some openness in regard to which similarities can be discovered/interpreted to underlie the metaphorical relation; this involves a process of meaning imposing, mostly pronounced in a context of explicit learning (or problem-solving), for example, discovering/interpreting what the metaphorizing term and the metaphORIZED term are, which possible similarities underlie the metaphorical relation etc. This thinking process concerning discovering/interpreting, involves, to a certain degree, effortful thinking and, as said, is accompanied by uncertainty because the cognitive metaphor concerns a “maybe-be”, qua abduction, and, thereby, “only knowing possible relations” of similarity between things/concepts. And, as already Aristotle contended in the *Rhetoric*, are those metaphors which have the greatest cognitive potential, metaphors which are: “..drawn from objects to the object in question, but not obviously related; in rhetoric as in philosophy the adept will perceive resemblances even in things that are far apart.” (cited from Eco 1984: 103). Thereby, we have returned to pointing toward the complexity of discovering/interpreting similarity and effortful

thinking in relation to cognitive metaphor – namely, covering a distance between things which are conceptually far apart. In short, we believe, then, that cognitive metaphor, potentially, exhibits key features of higher-order thinking as listed by Resnick; hence, involving complexity, yielding multiple interpretative solutions, as well as involving uncertainty and effortful thinking. Metaphorical thinking can be taught to and learnt by students; including taught and learnt in relation to higher-order thinking skills, which we believe that cognitive metaphor can be involved in as well as influence. However, before we can address this, as mentioned in the introduction, concerning transfer, critical thinking and problem-solving, we need to look a little more into how metaphor works as a process of thinking. Let us, firstly, return to Lakoff and Johnson again. According to Lakoff and Johnson metaphorical thinking concerns: “...understanding and experiencing one kind of thing in terms of another.” (Lakoff and Johnson 1980: 5). More precisely, they said, does metaphorical thinking involve understanding and experiencing something from one conceptual domain, the target domain, in terms of concepts which stem from another domain, the source domain. In short, is metaphorical thinking a process of conceptualization. And, this process of conceptualization involves that a so-called cross-domain mapping is taking place. Lakoff (1993) accentuated how:

The locus of metaphor is not in language at all, but in the way we conceptualize one mental domain in terms of another. The general theory of metaphor is given by characterizing such cross-domain mappings. And in the process, everyday abstract concepts like time, states, change, causation, and purpose also turn out to be metaphorical. (Lakoff 1993:203)

The cross-domain mapping involves that elements of a more abstract conceptual domain become related to concepts from a more concrete domain; where the last-mentioned concepts are concepts related to or grounded in direct (embodied) experience. And, we will add, with the cross-domain mapping process we also find, in relation to cognitive metaphor, the conceptual movement going

from the familiar to the unknown, whereby the unknown becomes meaningful and can be explained. The cross-domain mapping process furthermore involves, when the source domain structures (parts of) the target domain, the projection of an inferential structure. As Clark and Cunningham (2006) described, commenting on the theory of Lakoff and Johnson in their article “Metaphors we teach by: An embodied cognitive analysis of No Child Left Behind”:

The structure mapped from source domain to the target domain in metaphor also provides a logic that is a basis for reasoning. Entailments of metaphors refer to consequences of their particular structuring. Metaphor is ‘inference preserving’ in that it projects the inferential structure across conceptual domains. (Clark and Cunningham 2006: 271)

A possibility is, we think, that the projection can be of an abductive nature as we have explained in relation to cognitive metaphor – where the projection itself is abductive (seen from the perspective of the metaphor-maker) as well as the thinking which takes place in the interpretation of the metaphor. The cross-domain mapping is always partial, not total; the source domain only structures a part of the target domain. Said in other words, with metaphor is attention drawn to parts of the target domain while other parts of the target domain are omitted or downplayed. This important fact concerning metaphorical thinking can also be understood in relation to how Max Black, in his seminal paper “Metaphor” (1955), talked about metaphor as a filter. According to Black does metaphor concern a certain relation between two distinct subjects, namely the principal subject (the metaphorized subject) and the subsidiary subject (the metaphorizing subject) (later called focus and frame by Black, 1979) – and he gave the metaphorical example “human beings are wolves” (a variant of Hobbes’ *homo homini lupus* theme). This statement is meaningful, said Black, because it activates, in the interpreter, what he called a system of commonplaces, that is a complex of established or implicated ideas, concerning wolves, and this system of common places becomes related to the principal subject human beings. Hence, the interpreter, as well as the metaphor-maker

of course (both belonging to the same speech-community), know that “wolf” normally refers to is a fierce, carnivorous, and treacherous being etc., and it is some of these established ideas, through the subsidiary subject, which now become associated with human beings. Or, more precisely perhaps, with the metaphor is a set of associated implications projected onto the principal subject. Black himself explained how metaphor works in the following way (and we quote in extenso):

A speaker who says " wolf " is normally taken to be implying in some sense of that word that he is referring to something fierce, carnivorous, treacherous, and so on. The idea of a wolf is part of a system of ideas, not sharply delineated, and yet sufficiently definite to admit of detailed enumeration. The effect, then, of (metaphorically) calling a man a "wolf " is to evoke the wolf-system of related commonplaces. If the man is a wolf, he preys upon other animals, is fierce, hungry, engaged in constant struggle, a scavenger, and so on. Each of these implied assertions has now been made to fit the principal subject (the man) either in normal or in abnormal senses. If the metaphor is at all appropriate, this can be done-up to a point at least. A suitable hearer will be led by the wolf-system of implications to construct a corresponding system of implications about the principal subject. But these implications will not be those comprised in the commonplaces normally implied by literal uses of man ". The new implications must be determined by the pattern of implications associated with literal uses of the word " wolf ". Any human traits that can without undue strain be talked about in " wolf-language " will be rendered prominent, and any that cannot will be pushed into the background. The wolf-metaphor suppresses some details, emphasizes others-in short, organizes our view of man. (Black 1955: 288)

The effect is that metaphor works like a filter in the process of thinking; metaphor organizes experience and thought, it becomes a filter through which ideas, here what the human being is, can be seen from a perspective; with the metaphor the maker of the statement has not only selected

features of the principal subject, he or she has also emphasized and suppressed some of its features by applying the subsidiary subject to it. Even though metaphor works by activating systems of associated commonplaces this is not the same as saying that novel metaphors cannot be introduced; the novelty concerns which implications become introduced in the first place. For Black (as well as for Lakoff and Johnson) some metaphors may create cognition (concerning their makers and interpreters). So, we have returned to accentuate the cognitive potentials of metaphor; and, we will add, its relevance for higher-order thinking skills – because the cognitive metaphor, by summing up the above mentioned, makes possible the movement from the familiar to the unknown or experiencing one thing in terms of another by a process of discovering and interpreting (abductive) relations of similarity; metaphorical thinking is conceptualization and it involves cross-domain mappings with the partial structuring of a concept of relevance to cognition; or metaphor, working as a filter, has the potential to create perspectives and thereby new insights.

### **Transfer, critical thinking, problem-solving and metaphor**

Now it is time to turn our attention to metaphor in relation to the three higher-order thinking skills: (Knowledge) transfer, critical thinking and problem-solving. Transfer, critical thinking and problem-solving are all recognized as important skills in relation to higher-order thinking (Lewis and Smith 1993; Brookhart 2010: 3; Kereluik et al. 2013: 130); there is an overwhelming amount of literature dealing with these three skills taken alone or in some combination, for example, transfer and problem-solving (Salomon and Perkins 1987), transfer and critical thinking (Lai 2011), and critical thinking and problem-solving (Ennis 1987; Wade 1995; Angelo 1995; Willingham 2007). Furthermore, literature concerning the three skills stems from three different academic disciplines: Philosophy, (cognitive) psychology and education. And, these academic disciplines have (naturally) developed different approaches to the three skills according to their respective theoretical

frameworks, as well as concerns and goals of knowledge – not saying that we cannot find, for example, inter-disciplinary approaches (for example, combining both philosophy, psychology and education e.g., Quellmalz 1991). Because of the wide range of attention which transfer, critical thinking and problem-solving have received, and still is receiving, it is not surprising, that a vast number of definitions and descriptions of the three skills have emerged. However, many definitions, to the best of our knowledge, point toward at least (some of) the following characteristics concerning transfer, critical thinking and problem-solving:

- *Transfer*; concerns applying knowledge to a new situation or context; the transfer must take place in a deliberate manner and the knowledge must be applied or re-represented on a level which is different from the level in relation to which the knowledge was first acquired (context). Furthermore, the difference between levels concerns that the (new) second level involves or refers to a higher degree of complexity, for example, where this level covers more cases than was covered in the original context or the concepts are of a more abstract nature (Solomon and Perkins 1987; Carson 2007; Brookhart 2010; Grabe and Grabe 2012).
- *Critical thinking*; concerns reasonable and reflective thinking or simply reasoned judgements; critical thinking is careful and goal-oriented and the focus is on what something means and to decide whether or not to believe it; for example, to decide whether something is true/false, right/wrong, good/bad etc. Hence, critical thinking is evaluative in nature and therefore it relies on standards of scope, goals, criteria, and methods, appropriate to the thinking and the domain – for example, identifying and calling into question assumptions and premises and their relations within a given discourse (Quellmalz 1987; Ennis 1987; Norris and Ennis 1989; Lewis and Smith 1993; Baillin et.al. 1999; Brookhart 2010; Hitchcock 2020).
- *Problem-solving*; concerns identifying and understanding something as a problem, searching for a solution to the problem, carrying out the solution, and testing/reviewing the solution;



problem-solving is goal-oriented and seeks to overcome (or least modify) something in an environment which hinders the attainment of the goal. Problem-solving involves the use of knowledge in relation to a new situation and/or context; and, therefore the use is not automatic (Dewey 1933; Krulik and Rudnick 1987; Polya 1988; Davidson and Sternberg 2003; Carson 2007; Nitko and Brookhart 2007).

In relation to the above-mentioned descriptions, we can understand why (knowledge) transfer, critical thinking and problem-solving must concern higher-order thinking skills having Resnick's before mentioned list in mind. All three skills, to a certain degree, will involve complexity, multiple interpretive solutions, uncertainty, and effortful thinking. Furthermore, in concrete educational/learning situations the three higher-order thinking skills will probably be interwoven – for example, transferring knowledge from one domain to another in relation to problem-solving critically noticing problem similarities. Yet, the question is how can we couple metaphorical thinking to the higher-order thinking skills transfer, critical thinking, and problem-solving? If we begin with transfer let us firstly remember Greek etymology and how Aristotle described metaphor – in *Poetics* the philosopher wrote: “Metaphor consists in giving the thing a name that belongs to something else” and he explained that “the giving” concerns a “transference” (1457b 6–9); without focusing on technicalities here (Eco 1984: 91-96) this does not seem to go against how we have described cognitive metaphor in the previous pages; and, Mácha, in the article “Metaphor in Analytical Philosophy and Cognitive Science” (2019), discussing Aristotle, explained how metaphor: “...is defined in terms of transference (ἐπιφορά, epiphora). Phora is, in Aristotle's *Physics*, a kind of change (kinêsis), it is a movement from one place to another. (Mácha 2019: 2249). Hence, with Aristotle metaphor simply means “transference”; indeed, thinking of how we have described cognitive metaphor this does also make sense. Cognitive metaphor involves, then, a transfer from the familiar (knowledge) to the unknown – for example as a (abductive) discovery/

interpretation of new similarities and the cross-domain crossing from a source domain to a target domain whereby a concept becomes partially structured; this also involves, we think, because the metaphor is indeed cognitive, the transfer to a level of a higher complexity, because as Lakoff and Johnson (1980) accentuated: "...B (the defining concept) is more clearly delineated in our experience and typically more concrete than A (the defined concept) (Lakoff and Johnson 1980: 108-109). And Johnson in *The Body in the Mind: The bodily Basis of Reason and Imagination* also stated how:

[T]hrough metaphor, we make use of patterns that obtain in our physical experience to organize our more abstract understanding. Understanding via metaphorical projection from the concrete to the abstract makes use of physical experience." (Johnson 1987: XV)

However, the effect of the cognitive metaphor is that this second level or more abstract context becomes intelligible (in a new way) and reduced in complexity, because it will, due to the transfer (of meaning), be partially structured. Furthermore, we can understand transfer and cognitive metaphor with Lakoff and Johnson's three overall categories of metaphor, namely, orientational metaphors, ontological metaphors, structural metaphors. Or, we can now say that there are three basic ways in which transfer can take place, in order to, with the words of Lakoff and Johnson: "conceptualize the less clearly delineated in terms of the more clearly delineated." (Lakoff and Johnson 1980: 59); hence:

- *Oriental metaphors*; where the transfer concerns the experience and understanding of a concept in terms of a spatial orientation; these metaphors are related to our bodily structure and motorial function and our interaction with the physical world and cultural environment; these metaphors organize, in a systematic way, whole conceptual domains; for example, the spatial dichotomy up/down will underlie the transfer, that "health and life is up", whereas

disease and death are down – “his health has top priority”, “his health is declining”, “he dropped dead”.

- *Ontological metaphors*; where the transfer concerns the experience and understanding of intangible and abstract concepts in terms of entities, physical objects, and substances, whereby it becomes possible, as Lakoff and Johnson (1980) explained, to refer to these concepts and: “...categorize them, group them, and quantify them - and, by this means, reason about them” (Lakoff and Johnson 1980: 25); for example, do inflation become an entity and, thereby, can we think and talk metaphorically and, thereby, meaningfully, about inflation as follows: “Inflation is lowering our standard of living”, “If there is much more inflation, we’ll never survive” and “We need to combat inflation” (Lakoff and Johnson 1980: 26).
- *Structural metaphors*; where the transfer concerns the experience and understanding of a conceptual domain through another conceptual domain which is more well-structured or less abstract; structural metaphors involve that the entire target domain or principal subject (Black) become represented partially and not simply some of its concepts; Lakoff and Johnson (1980) used “Argument is war” as an example and they said: “We can actually win or lose arguments. We see the person we are arguing with as an opponent. We attack his positions and defend our own. We gain and lose ground. We plan and use strategies.” (Lakoff and Johnson 1980: 4); hence, an argument, is, indeed, reflected in experiencing and understanding war because the actions of argumentation are structured according to war, warfare, battles etc.

If you teach and learn cognitive metaphor you can also teach and learn the higher-order thinking skill concerning transfer; because transfer is the central meaning-making mechanism in metaphor itself. Metaphor opens up for higher-order thinking, when students go from a familiar conceptual

domain to a less known, or even previously unknown, domain, by understanding metaphorically, again using Lakoff and Johnson's terminology, orientational, ontological and structural experiences. As when students become aware of how and why others and themselves use metaphors; for example, in relation to understanding (and communicating about) a complex topic such as "global warming" with the structural metaphor "greenhouse effect", by reflectively thinking about the transfer of knowledge from one, more concrete, conceptual domain (increasing the temperature within a greenhouse) to another much more abstract domain (the complex processes concerning the increase of temperature within earth's atmosphere). When students understand and use cognitive metaphor in a reflective way it can become an important tool for advancing transfer. Pugh et. al., in their book *Bridging - A Teacher's Guide to Metaphorical Thinking* (1992), came to the same conclusion and put the point in the following way:

Metaphorical thinking cuts across subject and discipline boundaries by making knowledge in one domain a guide for comprehending knowledge in another, with some transfer of meaning taking place. [T]he basic meaning of the term transfer also implies the idea of a bridge. To be a metaphorical thinker is to be a constructive learner, one who actively builds bridges from the known to the new. (Pugh et. al. 1992: 4-5)

And, we may add, when students become reflective metaphorical thinkers, they also engage in and are influenced by higher-order thinking such as transfer. Let us now address cognitive metaphor and critical thinking. In his book *Developing critical thinkers* (1987) Brookfield stressed that:

"Identifying and challenging the assumptions by which we live is central to thinking critically" (Brookfield 1987: p. 89). And, after having read Lakoff and Johnson (1980), that most thought, and therefore speech, are metaphorical, we can add, that a part of critical thinking must (also) be to identify and challenge the assumptions of the metaphors we and others live by – or, at least, to ask if there are "other ways" of looking at this? Perhaps, by finding new, alternative

metaphors (see also Ivie 1996; Petrilli 2006). It is relevant to remember, however, that there is a difference between conventional metaphors and new metaphors (and we understand both as cognitive here); the first mentioned conventional metaphors concern concepts which are systematically conceptualized in terms of other concepts; or formulated differently, these metaphors are established as a mode of thought (and reflected in everyday language) among the members of a speech/language community, where they, as Lakoff and Johnson (1980) wrote, govern: "...what we perceive, how we get around in the world, and how we relate to other people." (Lakoff and Johnson 1980: 3). Yet, even though conventional metaphors are fixed within the lexicon they are nevertheless alive; they are alive because they structure, how to act, think and feel; or, a conventional metaphor, for example, structure how to act, think, and feel concerning time, where time is conceptualized as money and a limited resource and therefore can be wasted (Lakoff and Johnson 1980: 55); with affinity should one not "waste others time" – hence, one should *know* to be on time (hence *acting* in the correct way) and if one is not on time, one should *feel* bad (and probably apologize). Conventional metaphors are used automatically and effortless (and are, thereby, not realized as metaphors by their users); they express existing ways of thinking and are taken for granted. Therefore, it is also central to be aware of that there are cultures, for example, where time is not conceptualized as money or as a limited resource. Hence, Lakoff and Johnson (1980) pointed out how "time is money" and "time is a limited resource" are metaphorical but not universal metaphors:

...since we are using our everyday experiences with money...to conceptualize time. This isn't a necessary way for human beings to conceptualize time; it is tied to our culture. There are cultures where time is none of these things. (Lakoff and Johnson 1980: 8-9)

And as a consequence, as accentuated by Clark and Cunningham (2006), can conventional metaphors also involve a certain danger. So, they explained: "The danger is in accepting one

perspective as literal and true, leading to unexamined assumptions, unexplored alternatives, and inappropriate and possibly immoral applications of our...ideas.” (Clark and Cunningham 2006: 276). Without (sometimes) being critical aware, then, of conventional metaphors, there is no awareness either of how these metaphors, for example, can determine and constrain thought, action and feeling. Different from the conventional metaphors are the new metaphors. These (non-conventional) metaphors are new cross-domain mappings and creative abductions (to a certain degree) not (yet) stipulated by the conceptual system. Thereby, do new metaphors assume a value in regard to cognition involving the possibility of experiencing something new in terms of something else (already known). This, however, gives the new metaphors a certain capacity in relation to critic and critical thinking. In her article, “Meaning, metaphor and interpretation: Modelling new worlds” (2006), Petrilli pointed toward how:

Metaphor provides new cognitive models and open to new worlds, new perspectives, and new interpretative orientations. The generation of meaning through processes of metaphORIZATION tells the possibility of creating new possible worlds beyond the actual...Thanks to its capacity to construct new worldviews, to further knowledge and perception [it also has the] capacity to orient behavior in relation to values. (Petrilli 2006: 112-113)

Hence, due to the capacity of new metaphors to create new world-views they can also advance critical thinking; because new metaphors can offer alternative ways of understanding, for example, beliefs, behaviors, and values which are considered acceptable within a society. In short, new metaphors can lead to new possible conceptualizations of existing concepts having consequences for thought, action, and feeling. As, for example, within the “political domain”, discussed by Lakoff (1996), when the liberal “nurturing-parent metaphor” was proposed as a new metaphor for the role of the government in the US., thereby, criticizing the conservative “strict-father metaphor”; hence, with the new metaphor was formulated an alternative to the disciplinary

metaphor, now understanding the role of government as caring for, assisting and protecting the citizen. However, we must still have in mind that both conventional metaphors and new metaphors function as filters only selecting and organizing parts of the principal subject (with Black) and, thereby, they furthermore, highlight and downplay (or even hide when used strategically) parts of the target domain (Lakoff and Johnson 1980). This opens up for critical thinking, because as Lakoff and Johnson (1980) wrote: “In allowing us to focus on one aspect of a concept...a metaphorical concept can keep us from focusing on other aspects of the concept that are inconsistent with that metaphor.” (Lakoff and Johnson 1980: 10). Hence, by being aware of that both conventional metaphors and new metaphors function as filters, the (possibly) otherwise unacknowledged assumptions, beliefs, norms, values etc., underlying metaphor, can be critically examined, questioned and perhaps challenged. An interesting experimental study, within the area of second language education, was made by Littlemore in 2004, where she compared two groups of students both participating in a “critical thinking” session. One of the two groups, however, also participated in another session, where they were introduced to conceptual metaphor theory and how metaphor can shape/influence thinking. Littlemore wanted to find out whether she could see a difference between the two groups concerning their critical thinking skills. Therefore, students from both groups took a critical thinking test where they should analyse several texts and all texts included conceptual metaphors which were central to the persuasion of the reader concerning certain ideas. Littlemore (2016) in a later article summed up the results of her study as follows:

The students who had received the metaphorical awareness training were significantly more likely than those in the control group to make explicit references to metaphor in their critical analyses. While none of the students in the control group made any reference to the underlying metaphor, of the fifteen students who had attended the metaphoric awareness-raising session, seven made explicit references to the underlying metaphor and used these

references to support their critical evaluations. They were able to point out how the authors used metaphor to make sweeping generalizations, and to avoid discussing specific factors. They were also able to point out that metaphors can be understood on different levels, leading to different interpretations of the text, and they were able to point out limitations of the metaphors involved (Littlemore 2016: 6)

Hence, the study made by Littlemore did point toward how the students introduced to conceptual metaphor theory, compared with the control group (the students who were not introduced to conceptual metaphor theory), were significantly more likely to involve a critical evaluation of metaphor in their analysis of the texts. And, in particular these students did benefit from an understanding of how metaphor involves levels of connective thinking; metaphor is always a partial representation of a target domain, whereby, some concepts are foregrounded; however, in these text cases the metaphors suggested meanings which by the students were interpreted as “oversimplifications” (sweeping generalizations), also hiding aspects of the concepts represented. This led the students to characterize the metaphors as flawed or weak in their argumentation/persuasion. If you teach and learn cognitive metaphor, we will conclude, you can also teach and learn the higher-order thinking skill concerning critical thinking; this is because understanding how cognitive metaphor works and how it is pervasive in all aspects of life, including endowing personal, social and cultural life with meaning, can also foster an analytical, reflective focus on the importance of identifying and critically evaluating that behind every metaphor lies a number of assumptions which represent certain beliefs, behaviors and values etc. In his article “Metaphors: Tools for critical thinking” (1996), Ivie put forward a similar point:

Critical thinking highlights the importance of reflective thought. We think reflectively whenever we carefully examine the assumptions underlying our beliefs. Assumptions; in turn, are frequently expressed in the language of metaphor, hence metaphor offers us a useful tool



for analyzing complex systems of thought...Forming the habit of analyzing metaphors is an essential step in becoming a reflective thinker. (Ivie 1996: 67)

Most interesting is it, we find, how Ivie also accentuated that “forming habits of analyzing metaphors” is a key element in the process of developing critical thinking; thereby, he opened up for, we believe, the possibility of the teaching and learning critical thinking through knowledge of metaphor. Finally, let us look into the possible relationship between cognitive metaphor and problem-solving. We have already argued for how cognitive metaphor can play an important role in respect to both transfer and critical thinking and we believe that both transfer and critical thinking, at least in some ways, will underlie problem-solving. Firstly, the question is what constitutes a problem. In *Problem Solving: A Handbook for Teachers* (1980) Krulik and Rudnick defined a problem as follows:

...a situation, quantitative or otherwise, that confronts an individual or group of individuals, that requires resolution, and for which the individual sees no apparent or obvious means or path to obtaining a solution. (Krulik and Rudnick 1980: 3)

Hence, a problem concerns a situation where someone is facing something which needs a solution; however, reaching the solution cannot be done automatically or with a solution that is already memorized and therefore is the means to the reach the solution unknown (for now). With affinity, did Krulik and Rudnick characterize problem-solving as the means:

...by which an individual uses previously acquired knowledge, skills, and understanding to satisfy the demands of an unfamiliar situation. The student must synthesize what he or she has learned, and apply it to a new and different situation. (Krulik and Rudnick 1980: 4)

It is obvious that (knowledge) transfer is involved in this description of problem solving; and, indeed, thinking of how cognitive metaphor has been characterized in the previous pages the

description furthermore reminds us of a fundamental characteristic of cognitive metaphor, namely, to bridge from the known to the new or unknown. Of course, not every case of transfer will concern cognitive metaphorical thinking, nor will every process of problem-solving involve metaphor; however, cognitive metaphor can, no doubt, play a role in problem solving (see also Keefer and Landau 2016). And, where we before have talked about the target domain (or principal subject) in cognitive metaphor, we will simply now talk about the “target problem” and thereby understand problem-solving as a process whereby features of a target problem become mapped onto a (more) well-known and well-defined concept; or, the unfamiliar situation, the problem target, is now experienced in terms of something else, perhaps another situation, and the identification and understanding of the problem has begun as well as the influence on what later, critically, will be considered a possible solution to the problem and the test/review of this solution. In their article “Metaphor and analogy in every day problem solving” (2016) Keefer and Landau, with a slightly different terminology (talking about structure mapping), stated a similar point:

Structure mapping enables problem solvers to access a conceptual structure common to both a well-known concept and a less familiar problem (or solution). In this way, the well-known concept serves as a framework that can influence one or more stages of problem solving (Keefer and Landau 2016: 394)

Using cognitive metaphor in problem-solving means, in other words, to assume that metaphor can help to reason (abductively) about the problem and that it is possible to solve a problem by thinking of something else which already can be found, at least partly, in another context. Of course, going from features of the problem target and to the (more) well-known and well-defined concept involves the discovery of a relation of similarity between problem and concept relative to the complexity of the problem at hand. And, here we can return to Peirce’s description of abduction and how we understand the way in which abduction is related to cognitive metaphor:

A well-recognized kind of object, M, has for its ordinary predicates, P1, P2, P3, indistinctly recognized. The suggesting object, S, has the same predicates. Hence, S is of the kind of M.  
(CP 8.64; 1891)

The “suggesting object S” we see as the target problem and with the cognitive metaphor the target problem becomes related to M the “well-recognized object”, whereby the problem solver can conclude, tentatively, that the target problem, due to a number of shared predicates, is similar to another problem, situation, process etc. In order to discover the relevant predicates between the target problem and the well-known and well-defined concept, which will then underlie the mapping and thereby the understanding of the problem and its possible solution(s), the problem solver will make use of one, or a combination of, the three overall possibilities concerning transfer: Mapping orientational, ontological or structural experiences. When the problem of global warming is described and understood, for example, in relation to the “greenhouse effect”, this metaphor involves a combination of mapping ontological, structural and orientational experiences. First, a greenhouse is a physical object, a thing, or it is familiar, concrete and tangible (an ontological experience); then, the panes of glass in a greenhouse function as to trap heat like the atmosphere functions to trap heat within the climate system (a structural experience); finally, when the sun shines through the glass rooftop of a greenhouse the temperature will continue to rise (an orientational experience) because the generated warmth will be prevented to escape by the glass rooftop. If the, more or less, effortful thinking of the problem solver(s) leads to the formulation of a cognitive metaphor which will, tentatively, explain the problem, this will also include that the problem is seen in a new perspective, opening up for further inferences concerning a possible solution to the problem – because if the problem, seen from this new perspective, “is of the kind of M”, then X, for example, could be a candidate for a possible solution to the problem or formulated differently. The cognitive metaphor gives the problem solver(s) access to a conceptual domain

shared by both the well-known and well-defined concept and the target problem; and thereby, due to the shared conceptual domain, the well-known and well-defined concept will work as a frame within which an applicable solution can become generated. As when, again returning to “greenhouse effect” metaphor, global warming is understood, where the heat movement process taking place with a greenhouse, is transferred/mapped onto the processes of energy exchange within the climate system (see also Vosniadou 1989). From this particular perspective, in order to generate solutions to the problem of the “greenhouse effect”, it can be asked and reasoned about what actions must/should be taken in order to let warmth escape? With affinity, Casakin (2011), in the article “Metaphorical Reasoning and Design Expertise: A Perspective for Design Education”, pointed toward the creative potential of the (cognitive) metaphor in relation to problem-solving; hence, he wrote:

Metaphors allow exploring innovative ideas, and reframing...problems anew. These cognitive strategies contribute to directing and organizing...reasoning by establishing connections with domains that are not naturally or usually associated to the...problem. (Casakin 2011: 33)

We believe that Casakin is right. When cognitive metaphor relates a target problem with a well-known and well-defined concept the creative potential concerning problem-solving is reflected in how atypical the juxtaposition is. Or, perhaps we can say, that the more remote and surprising the relation of similarity in the cognitive metaphor appears to be, the more likely is it, that a new perspective for solving the problem will be created. In any way, no doubt, is the dynamics between similarities and dissimilarities in cognitive metaphor central concerning conceptualizing the unfamiliar problem, because as already Aristotle contended in his *Poetics*, does: “...a good metaphor impl[y] an intuitive perception of the similarity in dissimilars.” (1459a). An important (semiotic) effect of the cognitive metaphor is, of course, that the target problem, in relation to the new created perspective, becomes reduced in complexity – and, thereby, is the problem “filtered”

through the cognitive metaphor. The “greenhouse effect” metaphor, again, helps to relate very abstract and complex physical knowledge with everyday experience. As we remember, however, this must also mean that some similarities between the target problem and the well-known and well-defined concept will be highlighted while other similarities will be ignored/left out. In relation to the last-mentioned point this is exactly where critical thinking is of utmost importance if a possible/relevant solution to the problem should be found. In his article “The Greenhouse Metaphor and the Greenhouse Effect: A Case Study of a Flawed Analogous Model” (2012) Cheng examined how the “greenhouse metaphor”, indeed, is a double-edged sword; Cheng acknowledged how this metaphor can help partially (for example people who have not studied physics) to understand a complex phenomenon such as global warming, however, and this is his central errand, he furthermore explained how the metaphor is critically incomplete because it highlights only certain features of the climate system and that has serious consequences. Hence, he wrote how the “greenhouse metaphor” leads to: “...a series of ideas that ignore the roles of the ocean in the process of thermal transfer within the climate system, and an underestimation of the time delay effect in climate change. (Cheng 2012: 106). Overlooking critically important dissimilar predicates between the target problem and the well-known and well-defined concept, then, can lead to an incomplete solution or, of course, that the problem will not be solved at all. If you teach and learn cognitive metaphor, we will conclude, you can also teach and learn the higher-order thinking skill concerning problem-solving; this is because understanding how cognitive metaphor works can open up possibilities of associating similarities between a target problem and a well-known and well-defined concept; thereby, the problem will become mapped/transferred onto the structure of the well-known and well-defined concept and that through orientational, ontological, structural experience. The mapping/transfer allows the problem solver(s) to reason about the problem from a certain perspective, namely, from the perspective of a number of shared predicates. And, from this perspective, can the problem solver(s) begin to identify possible solutions to the problem.

However, in this process it is very important that the problem solver(s) also will have a critical eye on what the cognitive metaphor leaves out including the dissimilarities between the target problem and the new concept. Only so can a relevant solution be found.

## **Conclusion**

As acknowledged in numerous articles, books, policy reports etc. are higher-order thinking skills of utmost importance for students to succeed in school/educational institutions and to prepare them for the labour market and contemporary life in general. The focus on higher-order thinking skills has led to reforms/changes in educational systems all over the world. We have argued how metaphor is relevant for higher-order thinking skills in general and (knowledge) transfer, critical thinking and problem-solving in particular – because metaphor is a central matter of thought influencing perception, thinking and action (as contended by Lakoff and Johnson). A focus on higher-order thinking skills and knowledge of the cognitive potentials of metaphor, can benefit both teacher and students in relation to any subject (and any academic discipline) when students need to be creative and critical and discover/interpret similarities between the already known and the acquisition of new knowledge concerning an unfamiliar topic (see also Botha 2009). Finally, in our article we have not touched upon the important topic of assessment of higher-order thinking skills; then, is there something which we need to pay special attention to, concerning the possibilities of assessment, when we introduce cognitive metaphor in relation to higher-order thinking skills? As far as we can tell the answer must be negative; when higher-order thinking is assessed the questions/assignments concern answers/solutions which are, to a certain degree, open-ended, unpredictable (do not follow a strict formular) and not routine; and what is/should be assessed is how well, accurate, etc. the “learning target” is reached by students, not metaphor “as such” – the use of metaphor, can be a part of the assessment, however, metaphor is “simply” one (important)

possible cognitive means which the student can use among other means with which metaphor can interact (association, imagination, deduction, induction etc.) in order to reach a learning target.

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