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Michael Polanyi on creativity in science*

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Abstract

We can know more than we can tell. In this paper we discuss how Polanyi applies his tacit knowledge concept to approach creativity in science. We argue that Polanyi not only is a theoretician on creativity, but also a very creative educator aiming to communicate widely, thereby, increasing legitimacy of science. In order to make tacit knowledge and other concepts and ideas more accessible to the general public, he extensively used analogies alluding to visual representations and even made use of new innovative media like film to complement written expositions.

Keywords: methodology ; Michael Polanyi ; creativity
JEL Classification

1 Introduction

Michael Polanyi was a maverick polymath of the first half of the last century. His intellectual interests ranged from physical chemistry (his original field of education) to epistemology, philosophy of science, political philosophy and economics[1].

His perspective on tacit knowledge is in particular inspiring for whomever is interested in creativity and, more particularly, scientific creativity. As we will develop in Section 4, Polanyi's view on creativity seems close to Poincaré's definition of mathematical invention[2] described as "the ability to unite pre-existing elements in new combination that are useful" with the additional qualification that "the most fruitful combinations are those that borrow from rather remote fields" (Poincaré, 1908, p. 28)[3].

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[1]For a precise biography of Michael Polanyi, see Scott and Moleski (2005), and more recently Nye (2011), putting Polanyi in the historical context of the development of the idea of social construction of science in the 20th century.

[2]In his Riddell Lecture "Science, Faith and Society" Polanyi refers anecdotally to Poincaré's *Science et Méthode* (Poincaré, 1920, p. 20) in support of the idea that scientific discoveries 'does not usually occur at the culmination of mental effort" but rather 'in a flash after a period of rest or distraction" ((Polanyi, 1946).

[3]"Qu'est-ce, en effet, que l'invention mathématique? Elle ne consiste pas à faire de nouvelles combinaisons avec des êtres mathématiques déjà connus. Cela, n'importe qui pourrait le faire ; mais les combinaisons que l'on pourrait faire ainsi seraient en nombre fini, et le plus grand nombre est absolument dépourvu d'intérêt. Inventer, cela consiste précisément à ne pas construire les combinaisons inutiles et à construire celles qui sont utiles et qui ne sont qu'une infime minorité. Inventer, c'est discerner, c'est choisir... Parmi les combinaisons que l'on choisira, les plus fécondes seront souvent celles qui sont formées d'éléments empruntés à des domaines très éloignés."

In an article entitled "Creative imagination", Polanyi questions the role of questing imagination in science "in going beyond what is already known in order to sense and articulate new coherences." (Polanyi, 1966a, p. 249). The role of questing imagination is depicted by Polanyi as an illustration of his account of tacit knowing or how we tacitly "integrate subsidiary clues, often known in themselves, into a focal awareness of a comprehensive whole." (Polanyi, 1966a, p. 249).

As noted by Hammond (2003), Polanyi does not often use the word creative and suggests that the reason for this could be that "it may well be that he was afraid that creativity was too close to the limitless aspirations of totalitarian systems with their repudiation of traditional values." (Hammond, 2003, p. 31). According to Hammond (2003), Polanyi insists that scientists "indwell the scientific tradition and by means of the tacit knowledge are enabled to break out into new insights" (Hammond, 2003, p. 32). In other words, Polanyi uses his tacit knowledge concept to approach the idea of scientific creativity.

For Polanyi, tacit knowledge cannot be reduced to 'stuff' or defined as a residual after accounting for explicit knowledge. It is rather a process (of tacit knowing) involving the commitment of a person who is embedded in a social and historical context. This process is elucidated by Polanyi through the extensive use of analogies, notably visual clues or representations such as visionary illusions and stereoscopic images.

Polanyi's perspectives on knowledge and creativity also influenced the way he perceived economic and social problems. Like Hayek, though from a different ontological perspective, he was strongly opposed to planning in science and in the academia because he considered that scientific discovery or creativity would be badly impeded by poor diversity. He was also concerned by the far reaching implications regarding the lack of transmission of tacit knowledge from one field or place to another that central planning would entail.

Finally, Polanyi also showed a strong interest in general public education, in particular with respect to the role and consequences of economic policies inspired by Keynes from which he borrowed the representation of the economy as a monetary circuit and his ideas to cure unemployment at the time the *General Theory* was published. His interest was not purely academic but also practical. He experimented with different tools for communicating and disseminating ideas, notably moving picture technology and chemical apparatus. Hence, Polanyi did go beyond theorising on creativity and engaged in popularising complex ideas through creatively employing innovative didactic tools. We will develop this point further in Section 5.

The organization of the rest of the paper is as follows. In Section 2 we discuss the epistemological background of Polanyi, which is crucial for understanding his perception of knowledge. In Section 3 we focus on Polanyi's specific vantage point on tacit knowledge. Section 4 contains a discussion of the relation between tacit knowledge and creativity. Section 5 concentrates on the practical implementation of Polanyi's view of tacit knowledge and creativity in the field of mass education. Section 6 concludes.

2 Polanyi's epistemological background

As for his epistemology, Polanyi was a realist in the sense that he thought that reality exists out of us and that the scientist commits to attaining truth through a search process. This is however an impossible quest just because the reality of the objects of science is independent of scientific theories. In a nutshell, reality is the knowledge we believe to have of it:

> If anything is believed to be capable of a largely indeterminate range of future

> manifestations, it is thus believed to be real. A statement about nature is believed to be true if it is believed to disclose an aspect of something real in nature. A true physical theory is therefore believed to be no mere mathematical relation between observed data, but to represent an aspect of reality, which may yet manifest itself exhaustively in the future (Polanyi, 1967, p. 190).

It follows that our knowledge of reality has an "essentially indeterminate content" and "deserves to be called a vision" as the Copernican system was insofar as it was shared and hence permitted later discoveries by other great scientists like Keppler and Galileo (Polanyi, 1966a, p. 251).

He is however a strong opponent to positivism.
First he criticised the distinction between analytics and synthetics which is a cornerstone of logical empiricism (Quine, 1951). Second he endorsed a specific definition of subjectivity, which is not opposed to objectivity:

> I think we may distinguish between the personal in us, which actively enters into our commitments, and our subjective states, in which we merely endures our feelings. This distinction establishes the conception of the personal, which is neither subjective nor objective. In so far as the personal submits to requirements acknowledged by itself as independent of itself, it is not subjective; but in so far as it is an action guided by individual passions, it is not objective either. It transcends the disjunction between subjective and objective. (Polanyi, 1958, p. 300).

The first opposition, however, does not make Polanyi a defender of Popper's 'naive' falsificationism[4]. As he wrote in "Scientific Beliefs":

> (...) the fulfilment of predictions in terms of observations is not in itself capable of validating a scientific statement. And we may add that even the converse of this is true. Our general conceptions of the nature of things cannot be strictly contradicted by experience, for they can always be expanded so as to cover any experience. This is often true even of specific scientific theories. (Polanyi, 1950, p. 29).

At first sight, this position seems in line with Lakatos' critics of the dogmatic falsificationism: "we cannot prove theories and we cannot disprove them either"(Lakatos, 1978, p. 16).
But Lakatos is strongly opposed to the 'conventionalist conception of science' Polanyi endorses, as his account of the Einsteinian research programme illustrates:

> But my reconstruction makes tenacity of the Einsteinian research programme in the face of alleged contrary evidence a completely rational phenomenon and thereby undermines Polanyi's 'post-critical'-mystical message. (Lakatos, 1978, p. 77, fn. 6).

From this perspective, Polanyi seems to stand on a closer position to Kuhn[5]
Like Kuhn, Polanyi suggests that a theory can only be accepted a "truth" for a specific community who share common values and beliefs. This view is assessed in particular in Polanyi (1958, p. 216):

[4]For the relations between Popper and Polanyi, see Jacobs and Mullins (2011). In particular, Popper's reaction to Polanyi's "The Stability of Beliefs" has been very incisive.

[5]The proximity of Polanyi and Kuhn's thoughts is usually interpreted as the influence of Polanyi on Kuhn's views, as acknowledged by Bernstein (1983, p. 57): "Like Polanyi, Kuhn is arguing that the tacit knowledge of the scientist may be more important for understanding science as it is practiced than what can be explicitly stated into propositions."

> Articulate systems which foster and satisfy an intellectual passion can survive only with the support of a society which respects the values affirmed by these passions, and a society has a cultural life only to the extent to which it acknowledges and fulfils the obligation to lend its support to the cultivation of these passions. Since the advancement and dissemination of knowledge by the pursuit of science, or technology and mathematics forms part of cultural life, the tacit coefficients by which these articulate systems are understood and accredited, and which uphold quite generally our shaping and affirmation of factual truth, are also coefficients of a cultural life shared by a community.

Moreover, even if Polanyi is reluctant to consider induction as a relevant scientific method[6], he nevertheless sees it as a valuable source of information and at the basis of discovery[7] as will be developped in section 4. As put forward by Sheppard (1999, p. 2):

> Polanyi's expressed view in PK [Personal Knowledge] is to agree that induction is indeed a far from reliable process, but that it nevertheless undeniably remains a valuable and principal source of information that has led to the formulation of many successful theories.

Polanyi is however not a radical constructivist as Kuhn is considered to be; he is rather a moderate one, or more precisely defending a social evidentialism (Stenmark, 1995). According to Stenmark, social evidentialism is linked with two conditions for rationality: the evidential principle according to which a belief is rational if it is expressed by an informed individual, and the social principle, which means that this belief needs to be shared by a community of informed individuals. It is the reason why Polanyi is not in line with or goes beyond Kuhn, as expressed by Moleski (2006, p. 21):

> From my point of view, all that is good in Kuhn's position is found in Polanyi, while there is no trace in Kuhn whatsoever of Polanyi's orientation toward purposes which bear upon eternity. Polanyi's worldview goes far beyond Kuhn's in its orientation toward truth as a metaphysical prerequisite for the progress of science.

3 Polanyi on tacit knowledge

Polanyi held an idiosyncratic view on tacit knowledge. The way it is usually tackled in the literature, i.e., in opposition to explicit knowledge, is "often inconsistent and confused" (Hedesstrom and Whitley, 2000, p. 5). For instance, in the economics and management literature (see Cowan et al., 2000; Nonaka and Takeuchi, 1995), tacit knowledge is viewed as potentially being rendered explicit or codified or, as impossible to formalise by principle without any further explanation. In the field of sociology of science, Collins (2001; 2010) offers taxonomies by contrasting unrecognised knowledge and unrecognisable knowledge or, in his later book, relational (or weak) from collective (or strong) tacit knowledge[8].

[6] Induction is the method put to the fore by positivism.

[7] In a personal communication Martin X. Moleski writes "I have never thought that Polanyi opposed induction *per se*. I think he opposed the idea that it could ever be reduced to a set of rules or that it could be strictly formalized. For Polanyi, a discovery emerges from the tacit dimension as a Gestalt switch that changes how we see part-whole relationships."

[8] In his 2010 book, Collins divides the territory of tacit knowledge in three areas: Relational (or weak) Tacit Knowledge (RTK); Somatic (or medium) Tacit Knowledge (CTK); and Collective (or strong) Tacit Knowledge

One key difference in Polanyi is that the distinction between explicit and tacit knowledge is considered as meaningless. Tacit knowledge or rather tacit knowing cannot be defined as a residual category; it is pervasive and an essential element of all knowledge, scientific, artistic or religious. In his terms: "all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable" (Polanyi, 1966b, p. 7).

For Polanyi, who has been influenced by Gestalt psychology, knowledge cannot be broken down in its different constitutive parts. More precisely, Gestalt psychology points to the fact that we can integrate the particulars of a physiognomy without being able to identify the particulars. Polanyi uses the following example:

> We know a person's face, and can recognize it among a thousand, indeed among a million. Yet, we cannot tell how we recognize a face we know. So most of this knowledge cannot be put into words (Polanyi, 1966c, p. 4).

An interesting ensuing feature of Polanyi's thoughts lies in his reluctance to consider that operations at a higher level could be accounted for by the laws governing its particulars forming a lower level.

Even though there are obvious surface similarities with Hayek's *The Sensory Order* (Hayek, 2014) and his views on complexity (see Festré, 2019a) due to their common influence of Gestalt psychology (see Polanyi, 2010), there are also crucial differences (see Ŏguz, 2010). Hayek did not embed Polanyi's idea that tacit knowledge is inherently attached to a person to the extent that tacit knowing involves a process of "indwelling". In the vocabulary of Polanyi, when we understand or master something, we begin to dwell in it (Polanyi, 1961, p. 148) or "comprehending a meaningful whole is a kind of participation in that whole, which can only be possible with the personal knowledge of it" (Polanyi, 1959, p. 49). In other terms, we interiorise those things, which in their turn extend our bodily existence and the world to which we belong. As Polanyi explains, tacit knowing is the result of a dual process, i.e., 'tacit inference' and 'tacit integration', as it can be identified in the visual perception. Tacit inference corresponds to subsidiary awareness (the awareness of the components of a whole in visual perception, e.g. the details of a face) and tacit integration corresponds to focal awareness (the focus on the whole or the act by which we understand or recognise that what we see is actually a face).

Therefore, the main concept in order to understand the notion of tacit knowledge is the concept of integration:

> This act of integration, which we can identify both in the visual perception of objects and in the discovery of scientific theory, is the tacit power we have been looking for. I shall call it tacit knowing. It will facilitate my discussion of tacit knowing if I speak of the clues or parts that are subsidiarily known as the proximal term of tacit knowing and of that which is focally known as the distal term of tacit knowing. (Polanyi, 1966b, p. 3).

He adds that

(CTK). The following quotation gives a rough idea of the principle that underlies Collins's taxonomy, as well as of the content of each of its three constitutive categories:

> Collective Tacit Knowledge turns on the nature of the social, Somatic Tacit Knowledge turns on the nature of the body, but Relational Tacit Knowledge is just a matter of how particular people relate to each other (Collins, 2010, p. 16).

> tacit inference and tacit integration (from subsidiary awareness to focal awareness) are characterized by the fact that 1) there is an asymmetry between them and 2) they are linked by a logical relation (subsidiary awareness is not sub-conscious). There are two kinds of irreversibility: first we cannot identify all the clues we have integrated (contingent irreversibility), second when we go back to the subsidiary we lost their joint meaning (logical irreversibility)(Polanyi, 1966b, p. 3).

We already pinpointed divergences between Polanyi and Popper in Section 2. As for the ontologic nature of knowledge, Popper states that scientific knowledge is objective, namely, "knowledge without a knower: it is knowledge without a knowing subject." (Popper, 1972, p. 109). Contrary to Popper, Polanyi emphasises "the knower's active participation in any act of knowing." (Polanyi, 1966a, p. 4).

There are also significant differences between Polanyi and Hayek, even if they agree on the fact that knowledge cannot be reduced to propositional knowledge. For Hayek, the tacitness of knowledge is related to its connectionnist approach of the mind as a classifier system based on abstract rules (Smith, 1997). For Polanyi, it is derived from a phenomenological body-mind approach:

> The tracing of personal knowledge to its roots in the subsidiary awareness of our body as merged in our focal awareness of external objects, reveal not only the logical structure of our personal knowledge but also its dynamic sources (Polanyi, 1966c, p. 60).

Polanyi's view on tacit knowledge has subversive implications for scientific knowledge in general but also for the organisation of society, of which, by contrast, Hayek was not completely aware.

First, for Polanyi, there is a parallel between visual perception and the logic of scientific discovery. Accordingly,

> scientific discovery cannot be achieved by explicit inference, nor can its true claims be explicitly stated. Discovery must be arrived at by the tacit powers of the mind and its content, so far as it is indeterminate, can be only tacitly known (Polanyi, 1966a, p. 1).

Second, since the process of scientific discovery is governed by the process of integration, of which we are not fully aware, "the process of formalizing all knowledge to the exclusion of any tacit knowledge is self-defeating" (Polanyi, 1966c, p. 20).

4 The relation between tacit knowledge and creativity

In Section 3, we have shown that Polanyi's view of tacit knowledge has far-reaching consequences in terms of scientific discovery and the organisation of science.

First, Polanyi's approach to tacit knowledge offers an interesting answer to the so-called Meno's paradox[9] as acknowledged in the Foreword to the 2009 edition of *The Tacit dimension* (Polanyi, 1966c) by Amartya Sen:

[9]The paradox is the following: "to search for the solution of a problem is an absurdity; for either you know what you are looking for, and then there is no problem; or you do not know what you are looking for, and then you cannot expect to find anything"(Polanyi, 1966c, p. 22).

> In contrast [to Plato], Polanyi argues that if tacit knowledge is a central part of knowledge in general then we can both 1) know what we look for, and (2) have some idea about what else we may want to know (Polanyi, 1966c, Foreword by A. Sen, p. xi).

The answer to the Meno's paratox lies indeed in the basic structure of tacit knowing as a sensory perception. As Polanyi writes, "tacit knowledge consists in the intimation of something hidden, which we may yet discover" (Polanyi, 1966c, p. 23).

Second, Polanyi's notion of tacit knowledge is indeed indisputably linked with his conception of science in its relation with reality (cf. his "Science and Reality" article (Polanyi, 1967)). Analysing the links between the discoveries by Copernicus, Kepler and Newton, he stresses the idea that Kepler's three laws solved problems involved in Corpernicus' system and some of its drawbacks and that Newton's theory of gravitation solved problems of Kepler's three laws. This concept of problem solving perfectly anticipates Kuhn's concept of paradigm shift. It is the reason why in his very influential book from 1962, *The Structure of Scientific Revolution*, Kuhn makes references to Polanyi's works in epistemology.

We have already emphasised that Polanyi draws a parallel between visual perception and scientific discovery in Section 3. It is noteworthy that in both case, he refers to the word "clues" and explain how these clues are instrumental and in the same time independent from the whole picture they permit to generate.
In describing the focal vs. subsidiary processes of awareness in visual perception in "The Structure of Consciousness" (Polanyi, 1965), Polanyi refers to stereoscopy [10] and uses the term "cues":

> we don't look at these two [the stereoscopic pictures] in themselves, but see them as clues to their joint appearance in the stereo-image. It is their function to serve as clues. ... The relation of clues to that which they indicate is a logical relation [italics due to M.P.] similar to that which a premise has to inferences drawn from it (Polanyi, 1969, p. 212).

In accordance with his conception of science he stressed in "Science and Reality" that

> problems are evoked in the imagination by circumstances suspected to be clues to something hidden; and when the problem is solved, these clues are seen to form part of that which is discovered, or at least to be proper antecedent of it. Thus the clues of a problem anticipate aspects of a future discovery and guide the questing mind to make the discovery (Polanyi, 1967, p. 188).

In both cases (visual awareness and scientific discovery) the clues disappear because they have logically produced something different: new knowledge. In fact, integration permits the emergence of higher levels of stable beliefs:

[10] Stereoscopy refers to the techniques used by 3D imaging for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision. Most stereoscopic methods present two offset images separately (about four inches from one another), one to the left and one to the right eye of the viewer (a metaphor for subsidiary awareness). These two images are then combined in the brain to give the perception of 3D depth (a metaphor for focal awareness).

> My analysis of consecutive operational levels necessitates the assumption of a principle which works in the manner of an innovation achieved by integration. The assumption that this process is evoked by the accessibility of the higher levels of stable meaning which it eventually achieves, seems compelling to me (Polanyi, 1966c, p. 90).

In an article entitled "What is painting?" (Polanyi, 1970, p. 660), Polanyi gives another example of the discontinuity between the two kinds of awareness, while referring to Wollheim (1963, p. 237):

> Depending on the distance at which we look at a painting, we either see a canvas and blobs or a painting, never the two at the same time.

The articulation between the two types of awareness also implies an emergence. Subsidiary awareness of a whole cannot be deduced from focal awareness of its constituting parts; it is strongly linked to imagination and invention or new knowledge:

> The clues of a problem anticipate aspects of a future discovery and guide the questing mind to make the discovery (Polanyi, 1967, p. 188).

The process of integration and consequently the emergence of novelty is for Polanyi undetermined, it is only based on potentiality:

> It is the image of humanity immersed in potential thought that I find revealing for the problems of our day. It rids us of the absurdity of absolute self-determination, yet offers each of us the chance of creative originality, within the fragmentary area which circumscribes our calling (Polanyi, 1966c, p. 91).

The parallel between Polanyi's view of tacit knowledge and the notion of creativity as defined by Poincaré is striking. As we have hinted at in the introduction, the way Poincaré is describing mathematical invention has a lot to do with visualisation.

As for Polanyi, this is perfectly clear. In his own early scientific carrier, he used visual representations in physical chemistry and recognised in his autobiographical essay *My Time with X-rays and Crystals* (Polanyi, 1962, p. 1) that his successful solution to "solve the mystery" of a diagram boosted his career, as reported by Biró (2020, p. 98).

5 The creative use of visualisation in mass education

As emphasised in Section 1, Polanyi was interested in economic and social matters and experimented and used motion pictures in an innovative way to enlighten the general public about issues such as the role and effect of macroeconomic policies in particular.

We refer here specifically to the two films: the "economic machines" he designed in his chemical laboratory at the University of Manchester in the 1930s and "Unemployment and money. The principles involved" (1940), a diagrammatic sound film aiming at disseminating key mechanisms of Keynes' *General Theory* while using moving icons[11].

[11] Later on, Polanyi published a book, *Full Employment and Free Trade* (Polanyi, 1945), which is the extended written version of the 1940 film, where he reproduced the similar icons and diagrams in order to illustrate the text. See Beira (2015); Moodey (2014); Festré (2019b).

As pointed out by Biró (2020, p. 4), Oscar Jaszi, a Hungarian-born liberal politician and social scientist, in a letter of 1935, drew Polanyi's attention to multiple experimental didactic approaches intended to illustrate complex economic processes[12].

Biró (2020, p. 89) also mentions the correspondence dated 1937 between Polanyi and Charles Sale, an official of the Rockfeller Foundation, about a project initiated by James D. Mooney, the president of General Motors Overseas (1922-40): a film visualising the economy for the masses, that might have been a source of pressure urging Polanyi to develop his own project.

The visual method employed by Polanyi's 1940 film is connected to the Neurath's *International Typographic System of Picture Education* (Isotype) known as the Vienna Method of Pictorial Statistics that flourished between 1925 and 1934.

The aim of this method was to establish "one international picture language (as a helping language) into which statements may be put from all the normal languages of the earth" with the naive presumption that seeing is equivalent to thinking as the slogans "education by the eyes", "teaching by pictures" or "words divide, pictures unite" suggest (Neurath, 1936, p. 17).

Polanyi had the hope that, by diffusing political economic ideas using visual tools in a creative way, he could make the general public more aware of the dangers of the scientific and materialist view of science, which was also penetrating the field of economics. He was upset by the cloister-like character of many economists of his time who preferred the *status quo*, i.e., giving statements that are deliberately inaccessible to the general public in order for it not to err in speculation. Polanyi was in full disagreement with this contention and took it as the symptom of a "craving for economic consciousness" (Polanyi, 2016, p. 11)[13].

More precisely in his 1940 film "Unemployment and money. The principles involved", Polanyi aims at modifying the perceptions and beliefs of people on how economic policies affect their concrete lives. As summarised by Biró (2020, p. 98),

> The film visualizes the economy as a continuously changing landscape, a monetary perpetuum mobile never coming to a halt. Establishing the correspondence between the economic micro- and macro-cosmos through showing the minutiae of their dynamics was important for Polanyi to be able to convince the masses about at least two things. First, that fundamentally invisible and hardly comprehensible economic macro-processes do affect their economic life. And second, that they can and should take certain macro-economic and social considerations into account when making economic decisions, developing a kind of economic consciousness.

Interestingly, Polanyi did 'play' with the Isotype method in a sophisticated way, which differ from other attempts. As pointed out by Biró (2020, p. 97), Polanyi made extensive use of the "process of revisualisation", i.e., did not freeze the association of visual symbols with a fixed meaning[14]. Clearly, this can be related to Polanyi's view on creativity as we have shown in Section 4. By changing the associations, Polanyi boosted people's imagination and delivered the message that the "relation of the mind and the economy is not a one-way but a two-way process" (Biró, 2020, p. 97).

[12]The experiments mentioned in the letter are: Franz Oppenheimer's plan "to illustrate the creation of the Mehrwert [added value] as an application of his geometric theory" and a "game board designed and patented by Normal Angell ... which illustrates the circulation of money and the distribution of gold stocks" (Polanyi, 1935) quoted by (Biró, 2020, p. 89).

[13]See Biró (2020, p. 94)

[14]For instance, the workers are depicted in different ways, i.e, with distinct clothes or using different symbols without any additional verbal or visual clues about why or in what sense they are different

But more fundamentally, he thought that this kind of initiative would be a way to solve the moral crisis to which Western countries are confronted. As he put it:

> No man can be satisfied by thinking of himself only; robbed of clear consciousness of his relations to those with whom he actually co-operates, he feels that the complex structure which thus isolates him is bad, inhuman, revolting. The burden of work of which the full meaning eludes us is demoralising; acquiescence to the inequalities in fortune can go on passively, unsanctioned by justice, or even by resignation based on a conviction of their necessity; but social self-respect is decaying amongst the rich, unrest is spreading amongst the poor (Polanyi, 1936, pp. 56-57)

He was convinced that the enlightenment of the mass that was urgently needed in order to preserve freedom in society could be achieved in part by using visual didactic devices. Polanyi hoped that the social spaces around these visual symbolisms of social matters were simple enough to be understood by a wide array of people, since he thought that "fundamental features of economics could be made widely appreciated by the public only by discovering an adequate visual symbolism for their presentation" (from unpublished Lecture entitled "Visual Presentation Of Social Matters" that Polanyi delivered to the Association for Education in Citizenship in Manchester, England in June of 1936[15]).

Polanyi was nevertheless aware of the deceptive potential of visual techniques and, therefore, cautious about using the term creativity in general without any further qualification. In his aforementioned article "What is painting" (Polanyi, 1970), he explains that if some paintings [16] give the illusion of being fully three-dimensional, it is due to deception, namely, to the absence of subsidiary awareness of the fact that paintings are mostly based on a flat canvas (Polanyi, 1970, p. 656). Needless to say that Polanyi was very knowledgeable about the various methods to manipulate intentionally people's awareness and certainly not naive of their possible use for political maneuvering.

6 Concluding remarks

It has been suggested that Polanyi reduces creativity to discovery (Hammond, 2003, p. 31). This seems to be a far too simplistic interpretation of Polanyi, analogue to interpreting Poincaré's famous definition of mathematical invention as discovery. Poincaré emphasises that mathematical invention is not to combine existing elements into new combinations (discovery). Most of such combinations have no interest. Only a small subset is useful. Inventing is the process to arrive at an element of this useful subset. This process may be called scientific creativity, but it is precisely here Polanyi goes deeper by invoking his concept of tacit knowledge and applying it to scientific creativity.

We have also in this paper seen that Polanyi did go beyond theorising on creativity and engaged in popularising complex ideas through creatively employing innovative didactic tools. As nicely put by (Biró, 2020, p. 98), Polanyi can be seen as 'boundary shifter' using unconventional visual practices to move from one social and disciplinary world to another.

[15] See Beira (2015, p. 7).

[16] Polanyi takes as an illustration the vault fresco of the church of Saint Ignazio in Rome painted by Andrea Pozzo about the turn of the seventeenth century.

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