Enhancing the design of a supply chain network framework for Open Education

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Abstract. This article addresses the problem of education in the knowledge society. More precisely it suggests to conceptualize Open Education as a supply chain in the form of a network of responsible citizens, switching roles and participating meaningfully in any education endeavour. It results in co-designing learning paths and creating common goods in the form of knowledge commons. These insights are gathered through a reflection conducted with a method of scholarship of teaching and learning, a theoretical framework of value creation (Wenger-Trayner & Wenger-Trayner, 2020) and epistemologies of absences and emersions (Santos, 2016), and a case study (Favre, 2021).

Keywords: Open Education, Knowledge society, Open Science, Supply Chain.

1 Introduction

The knowledge society and knowledge economy are underway: this is now an established fact but what does it mean in terms of science and education (David & Foray, 2003; Foray, 2002)? Is it clear in stakeholders' and citizens' minds that such a society and economy are goals to achieve and not accomplished states?

Knowledge is core in both Open Education (OE) and Open Science (OS) which are dedicated to co-creating and sharing common goods. In terms of science and education suppliers, Higher Education institutions are major players and they currently address the knowledge society challenge in the form of internationalisation (de Wit & Altbach, 2021; Jones & de Wit, 2021).

Within this dynamics, a growing awareness of the importance of rethinking science and education is a voice rising – be it from organisations like UNESCO or the League

of European Research Universities with recommendations for policy (Ayris et al., 2018; UNESCO, 2020a, 2020b), from international researchers who share their reflections in terms of epistemologies (e.g. Brière et al., 2019; Innerarity, 2015; Santos, 2016) or from new practices in terms of research funding (e.g. crowdfunding, citizen science). It highlights scientific practices that pre-existed copyright law (Langlais, 2015) and alerts about ecological impacts of a digital society and economy (Nardi et al., 2018).

From the perspective of supply chain management, education has been reported as a linear effort from pre-school to life-long learning with the interactions of different types of resources - intellectual, human, natural, financial, physical, etc. (Li, 2020). To move away from linear processes that fail to translate educational processes in a knowledge society, we have developed the concept of an Open Education Supply Chain (OESC) (Class et al., 2021). Based on the 3 basic principles of supply chain management - the design phase, which consists of developing 'roads' and 'nodes' through which physical, information and financial flows are managed; the planning phase of the flows, through advanced planning systems; and the control of the different flows at the operation level – the OESC is conceptualised as follows. Roads refer to the different type of competences and knowledge developed in institutional and certified settings as well as those developed in non-institutional settings, certified or not (e.g., self-learning). Nodes refer to the different educational stakeholders providing any given training – undergraduate, postgraduate, continuing education with or without accredited certification. They can provide face-to-face, on-line or blended training. The variety of potential roads and nodes conduce to the building of highly individual learning paths.

The purpose of this reflection, conducted in a scholarship of teaching and learning approach (Boyer, 1990) is to further develop the OESC concept with the support of a case study taking place at the lifelong learning centre of the University of Geneva (Favre, 2021). We first provide information with regard to the method and the theoretical framework. We then review the concept of OE from several perspectives and present the case study. Finally, we present our current understanding of OE conceptualised as a supply chain.

2 Method and theoretical framework

The methodology developed within this article is based on a Scholarship of Teaching and Learning (SoTL) approach (Boyer, 1990; Haigh & Withell, 2020; Hubball & Clarke, 2010; Miller-Young & Yeo, 2015). It describes researchers' progress and reflection on OE conceptualised as a supply chain. Using categories from Hubball and Clarke (2010, p. 4), Table 1 outlines how the outcomes shared within the present paper have been produced.

Table 1. SoTL methodology using the categories put forth by Hubball and Clarke, 2010

SoTL research context	**Central SoTL research question**	**Methodological approach**	**Data collection methods**	**General outcomes**

Contribute to the design and understanding of Open Education at the epistemological and at the praxis levels.	How can Open Education be designed as a supply chain network?	Action and reflection are guided by progress in the understanding of the breadth and depth of both Open Education and supply chain networks.	Data related to the case study is data collected within the Master thesis of Favre (2021).	Enhanced understanding and visual representations of Open Education conceptualized as a supply chain network.

The theoretical framework to guide this reflection is composed of value creation framework (Wenger-Trayner & Wenger-Trayner, 2020) (Figure 1) on one hand and on epistemology of absences and emersions (Santos, 2016) on the other. As specified in Class et al. (2021, p. 619), “Value is defined in terms of agency and meaningfulness of participation. More precisely, participating is perceived as conducting to a difference that matters.”

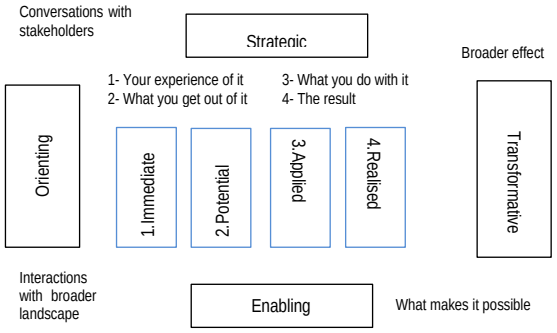

Fig. 1. Value creation according to Wenger & Wenger (2020, p. 75).

Epistemology of absences and emersions is a call to consider all the knowledge that science has deliberately set aside, evaluating it as non-scientific knowledge. It is a call to let knowledge express itself, without filtering it with "Western-centred" glasses of what scientific knowledge is. For instance, upon asking some stakeholders from countries in Latin America, to express key concepts in their native languages, these are related to elements (e.g. “water”, “fire”) or to the “Mother-Earth”. Finally, it is a call to stop the mindset of always moving into further development (e.g. planned obsolescence; artificial scarcity), not taking into account the resources that the planet is able to produce or absorb.

With the current ecological crisis we are living, in light of this epistemology and of others concerned with modern considerations of science and their inevitable crash (Latour, 2006), making space for ignored knowledge to emerge seems timely and wise. This is in line with Open Science as understood by UNESCO (2020a, pp. pp. 4-6) – i.e. openness towards the "diversity of knowledge" and towards "the process of scientific knowledge creation and circulation".

3 Open Education

3.1 Knowledge society

The knowledge society, as its name indicates, is based on knowledge. What is knowledge? How does it differ from information? Knowledge is defined as a cognitive capability that empowers its owners with intellectual and physical actions whereas information is formatted and structured data that lies there and becomes active when actors who have the needed knowledge to process it, do so (David & Foray, 2003). Knowledge-based communities, like those of open-source software programmers, create and reproduce extensive knowledge. They develop advanced strategies for sharing and disseminating the knowledge produced with the support of digital technologies. “Sharing knowledge is their raison d'être” whereas private companies regard new knowledge as an “exclusive property” to be monetized (David & Foray, 2003, p. 30).

3.2 Defining openness in Open Education

Openness, in a special issue of the Journal of Information Technology dedicated to openness and IT, is defined as being characterized by access, participation, transparency and democracy (Schlagwein et al., 2017). An analysis of relationships between the concepts of openness and education shows that depending the perspective adopted, a myriad of interpretation of both is possible. What matters is to consider 5 essential challenges framed in terms of values, theorizing sharing, standards, deep philosophical questioning and meta-critical thinking. (1) With regard to values, although openness and education are associated to positive connotations, they do not represent values "per se" (Hug, 2016, p. 5). (2) Sharing being an essential concept of OE, a huge work in terms of operationalizing and theorizing what sharing means is to be conducted. (3) Policies like UNESCO (2019)’s state recommendations for Open Educational Resources (OER) but the question of standards to allow practitioners really adopt them should be addressed seriously in its full breadth and depth. (4) Since OE draws on technologies, the "post or trans-humanist" (p. 5) complexity of IT and AI in education are philosophical questions to debate actively. (5) Finally, in academia, it is important to foster meta-critical thinking that goes beyond current contradictions (e.g. "involution of democratic achievements in the name of democracy" (p. 6)) to lay the ground for education as a common good and let knowledge commons emerge fully (Hug, 2016).

Indeed, education understood from the perspective of von Humboldt is "a means of realizing individual possibility rather than a way of drilling traditional ideas into youth to suit them for an already established occupation or social role" (Wikipedia, 2021b). Initiatives for open schools were conducted in the 1960s and 1970s relying on von Humboldt’s ideas. It is also at that time, and following his ideas, that Open Universities were established. Whereas the movement did not break through in schools, it did in open universities and paved the way to OER and MOOCs. Indeed, learning from the pendulum swung in the 1960s, OER were clearly associated to licensing and copyleft issues from their start in their design of the year 2000s. Quite interestingly, and this is an example of the contradictions mentioned by Hug (2016), MOOCs "deliberately

altered the criteria for openness insofar as it was now only open (i.e., cost-free) access instead of open licenses" (Deimann, 2016, p. 5).

3.3 Open Education invariants

It is obvious that Open Education, similar to Open Science, is in the process of being understood and can represent an umbrella term to flag a different way of approaching education (Burgos, 2020; Fecher & Friesike, 2014). Authors agree on underlying values that are: (1) geared towards humans and commoning (*vs* profit); (2) trustworthiness; and (3) ecological systems. For Kahle (2008), these values operationalize in a design for access (i.e. diversity of knowledge, universal design), for agency (i.e. degree of user action and control on the developed artefact), for ownership (i.e. making meaningful through ownership), and for participation (i.e. to take part in the life cycle of the artefact) and for experience (human-centred design). Many efforts are conducted to theorise, map and provide return of experiences with insights to advance our understanding of OE (e.g. Blessinger & Bliss, 2016; Conrad & Prinsloo, 2020; García-Holgado et al., 2020; Iiyoshi & Kumar, 2008; Orr et al., 2018; Pitt et al., 2020; Stacey & Hinchliff Pearson, 2017; Stracke, 2019; Teixeira, 2021; Weller, 2014; Weller, 2020; Weller et al., 2018; Wiley, 2017).

3.4 Assessing Open Education

Assessing competences and certifying them is an essential issue tackled from various perspectives in the literature and ranging from open admission to open credentials (Figure 2). Open admission, is understood as the changes of academic policy to open up admissions for everyone, without any prior certification requirements (Cronin, 2017). Open competencies are related to open assessment. In the form of a contextual catalog of competencies (i.e. in French, the so-called référentiel de compétences), they list knowledge and skills against which open assessment is defined (Gama et al., 2016; Wiley, 2017). Open assessment, is in its turn understood as assessment that showcases knowledge and skills developed using Open Education Practice and Open Educational Resources (Conrad & Prinsloo, 2020). Finally, Open credentials are understood as certifications issued by an accountable and authorized entity (e.g. institution, community) within a technological infrastructure over which learners have full control (Wiley, 2017).

Indeed, learners should be able to redistribute their credentials without involving third party bodies and be able to remix and regroup them in the way they want. They own and have full control over their credentials. To guarantee the validity of a credential, it must be tamper-proof, and the origin of the credential must be trusted (Wiley, 2017). Open credentials try to gain the trust by requiring transparency (Ehrenreich et al., 2020). To enhance the transparency and thereby the trust, the certifying entity has to take measures to increase the visibility of its practices. To do this, the certifying body shares detailed information on the competences developed, the design process, the syllabi, the assessment procedures, etc. (Inamorato dos Santos et al., 2016).

The need for alternative credentialing that documents lifelong learning completed online, in face-to-face and in blended modalities, in so-called semi-formal or informal ways, is growing (Janzow, 2014 cited by West et al., 2020). Alternative credentialing also allows to credit so-called transversal valued skills and knowledge that are known under the 21st century skills-set (Rios et al., 2020; WorldEconomicForum, 2016) but are not credited for in so-called formal systems (Finkelstein, Knight, & Manning, 2013 cited by Mathur et al., 2018). One manner of offering open credentials is through the use of badges. Badges are promising because they are portable and easy to share on social media (e.g. LinkedIn) (Mathur et al., 2018) even if today they assert only micro-knowledge and skills (Halavais, 2013).

Combining Open badges and Open competencies offer the opportunity to develop and get certified for micro-knowledge and skills upon learners' decisions. It is important that learners take the lead of their education journey – i.e. active learning *vs* being taught to build individual paths (Gama et al., 2016).

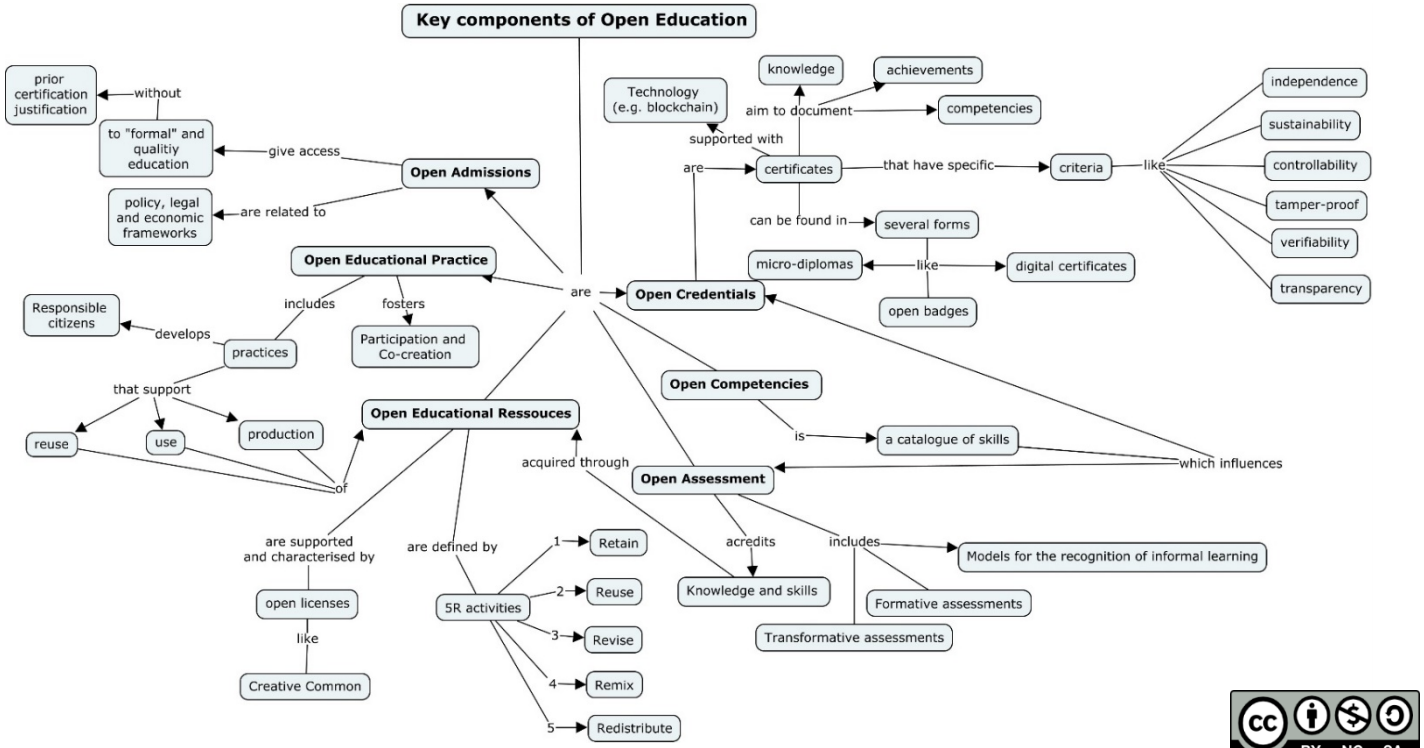
Key components of Open Education
prior certification justification
without
to "formal" and qualitiy education
give access
Open Admissions
policy, legal and economic frameworks
are related to
Open Educational Practice
Responsible citizens
develops
practices
includes
fosters
Participation and Co-creation
that support
reuse
use
production
of
Open Educational Ressouces
are supported and characterised by
open licenses
like
Creative Common
are defined by
5R activities
1
Retain
2
Reuse
3
Revise
4
Remix
5
Redistribute
are
Open Credentials
Technology (e.g. blockchain)
supported with
knowledge
achievements
aim to document
competencies
are
certificates
that have specific
criteria
like
independence
sustainability
controllability
tamper-proof
verifiability
transparency
can be found in
several forms
micro-diplomas
like
digital certificates
open badges
Open Competencies
is
a catalogue of skills
which influences
acquired through
Open Assessment
acredits
Knowledge and skills
includes
Models for the recognition of informal learning
Formative assessments
Transformative assessments

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Fig. 2. Key components of assessment in Open Education - inspired from Favre (2021)

With regard to the integration of Open credentials, the following criteria of inviolability, controllability, verifiability, independency, transparency have been identified as bottom-line to be followed. They are challenging especially in the sense of achieving a fully automated solution spread at large scale (Favre, 2021).

Acknowledging competences and knowledge on one hand and being able to show easily their validity can be made through open badges matched with blockchain technology (Figure 3) or a similar ecological technological process (Favre, 2021). Indeed, providers of open badges are multiple and certifications completed at micro levels diverse. It is thus a good solution to secure them in a back-pack (Figure 4).

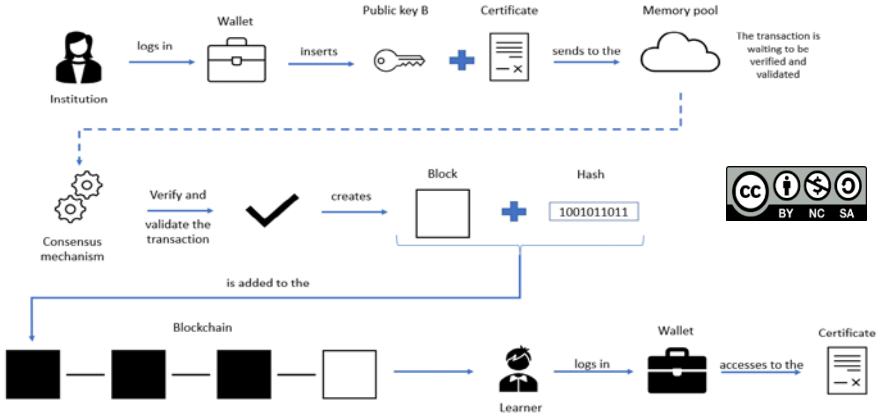

Fig. 3. Combining Open badge with blockchain technology, inspired from Favre (2021)

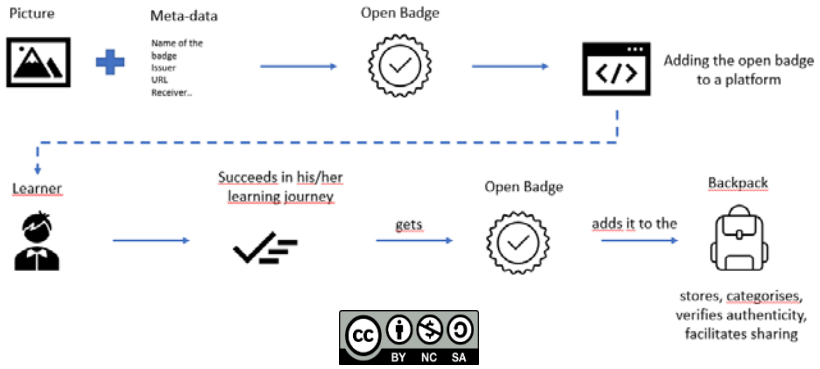

Fig. 4. Collecting Open badges or Open credentials in a secured back-pack, inspired from Favre (2021)

3.5 Open Ecosystem

Certification is important, among other things because OE is connected and interacts with the remaining social, economic and political worlds to name but a few. Stacey (2018) has represented this ecosystem in the form of a tree (Figure 5). Elements that are under earth are still in elaboration, not yet at the state of germination. Elements that are represented as leaves are already well developed and elements in between are those which are germinating. The particularity of OE, an element of this ecosystem, is to be a key component at the heart of it for at least 3 reasons. (1) OE creates new forms of each of these Open component, be it through practice, through theoretical contributions, through reflection or through all three – i.e. Freire (1994)'s concept of *praxis*. (2) OE uses these forms, tries them out, questions them in light of practice and policies, etc. and refines them over time. (3) OE allows continuing monitoring of knowledge and skills through close connections with the remaining elements of the ecosystem.

In a nutshell, the Open Ecosystem, as its name suggests, refers to the interactions and interconnections of the different components of a diverse and open landscape (FOSTER, 2018; Santos-Hermosa, 2019; Stacey, 2018).

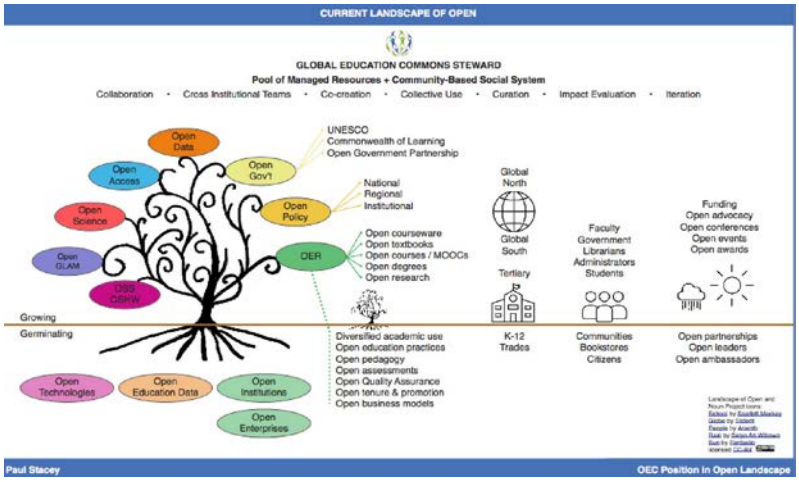

Fig. 5. The landscape of Open by Stacey 2018, https://paulgstacey.files.wordpress.com/2017/11/landscapeofopenstacey.jpg

4 Actors in the Open Education landscape

Whereas in the position paper (Class et al., 2021), we were strongly influenced by Stacey and Hinchliff Pearson (2017)'s tripartite perspective of the world – state, commons, market – we now think that it would be an error to consider the GAFAM as simply an actor from the market. Google, Apple, Facebook, Amazon et Microsoft (GAFAM) are more powerful than states (Wikipedia, 2021a) and take decision in all

domains, be it through direct processing of personal data from the internet or through the funding of organisations like the World Health Organisation for example (Crawford, 2021; McGoey, 2015; Rogers, 2016).

In addition, in light of the epistemology of absences and emersions (Santos, 2016), it is important to take into account ignored actors and stakeholders and bring them into the equation. Ignored actors represent the maximum of the unknown in the equation.

Revising actors' and stakeholders' mapping from the current situation (Figure 6) to the new situation (Figure 7) is a dynamic projection to help us think what the future could look like.

Fig. 6. Commons, state, market and ignored actors wiped out by GAFAM

Fig. 7. The return of Commons, ignored actors and the state with GAFAM scaled back within the Market's prerogatives.

At a finer granularity, from a Delphi survey conducted within a current project on OE, identified actors are public entities, lead thinkers, suppliers, community members, non-profit organisations and politics/legal representatives. Some of their roles and practices are depicted and vary from generating public goods to providing support through funding (Figure 8).

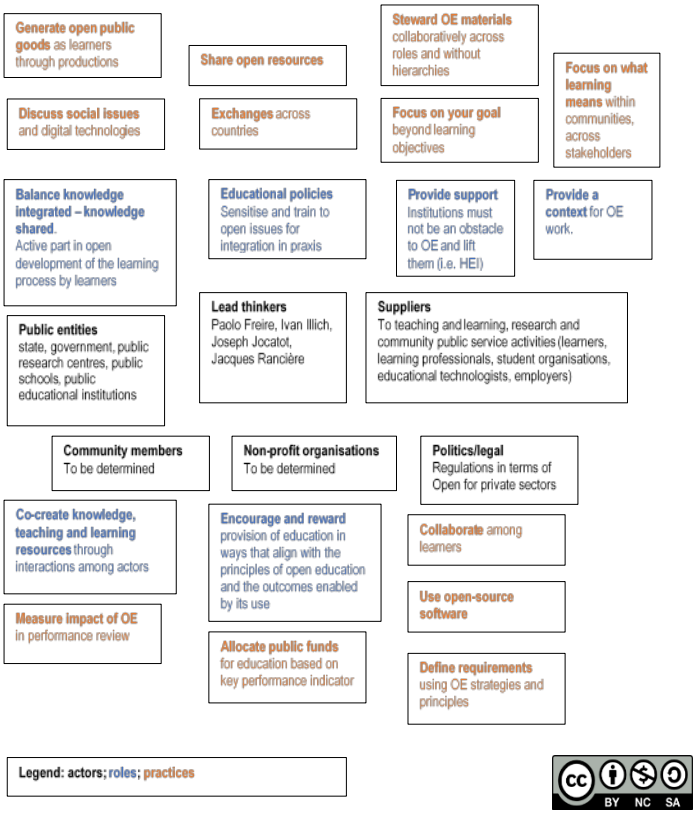

Fig. 8. Actors, roles and practices in Open Education

5 A case study

Some 15 years ago, the Swiss education system has uniformized its continuing education sector (Swissuniversities, No date), designing 3 main certifying diplomas – Certificate, Diploma and Master of advanced studies (CAS, DAS, MAS), each representing at least 10, 30 and 60 ECTS. Very similar to regular Bachelor and Master programmes, these trainings present the specificity of being oriented towards an audience of professionals who seek to advance their career or change their career path, adding new competencies to their background. These trainings are thus more practice oriented than regular Bachelor and Master curricula. They are designed to help participants develop their professional project, module after module, within a given training. Even if designed in a participatory manner with stakeholders from the economy and from academy, these programmes remain very closed and linear in the sense that participants are drilled through a given path within one pre-conceived programme. They cannot for instance mix module 1 of the CAS in digital learning with module 2 of the CAS in blockchain technology, etc. to come up with their own tailor-made CAS. Continuing education is

designed per programme and programmes are like silos designed per domain and per type of diploma.

In 2017, a new diploma has appeared in this Swiss continuing education landscape at EPFL and in 2020 at UNIGE: the Certificate of Open Studies (COS) (EPFL-UNIL, No date; Universite-de-Genève, 2020, article 65). This first attempt to offer OE complies with the open admission criteria (EPFL, 2018). With regard to all remaining key features – free access, OER, agency, empowerment, etc., the COS is still to be invented.

MOOCs also come to mind when talking about OE but MOOCs comply with the same and sole criteria of open admission. Certification is not free and above all, MOOCs do not qualify as OER as explained above since they have refused the principle of open licensing.

In terms of Open credentials, the conclusion of Favre (2021)'s study is full of insights. The current proof of concept underway at the University of Geneva aims at distributing securely diplomas with a blockchain technology. Its aim does not converge with Wiley (2017)'s OE above-mentioned recommendations for Open credentials as learners' capacity to redistribute and remix their credentials without involving any third party is not planned.

6 Supply chain applied to Open Education

6.1 Basics of supply chain

Learners taking roads through nodes (cf. introduction) generate flows, acting in a broader network and web of activities. Supply chain networks can be featured in terms of flow management, bottleneck management and queuing networks management (Bhaskar & Lallement, 2010). Flow management combines innovation and value-added operations and requires digital products and services to offer new value creation through dynamic flows within the network structure (Garay-Rondero et al., 2019). Bottleneck management refers to any process activity or constraining organizational performance where the system advances quicker than its slowest bottleneck component (Slack & Lewis, 2005). Bottleneck management consists in eliminating or acknowledging bottlenecks (Johnston et al., 2020) by locating and defining their origins and causes (de Bruin et al., 2005). Finally, queuing network analysis refers to identifying and modelling the performance of stochastic systems (Shortle et al., 2017).

6.2 Supply chain concepts applied to Open Education

Flow management in OE represents students requesting to participate to given learning sessions to gain knowledge and skills. As intelligent agents, they choose their own path and dynamically change it according to interactions with the remaining intelligent agents. Dynamic and continuous flow management is thus required to face potential bottlenecks. Bottlenecks in the OESC may happen when the number of open positions is limited with respect to the number of learners requesting the use of a specific node. This situation requires new forms of allocating resources to cater for demanded learning

opportunities. In OESC, stochastic systems refer to competences and knowledge sought for by learners. For a same input, different outputs can be offered, e.g. different learning sources providing targeted and sought for competences and knowledge. This is where dynamic queuing network management can help to redirect to the most appropriate and available learning sources. Furthermore, digital technologies enhance added value for learners and remaining stakeholders in terms of services, decision making, visibility and prediction (Dinter, 2013).

6.3 Four dimensions for Open Education Supply Chain

We have conceptualized OE as a supply chain inspired by Garay-Rondero et al. (2019)'s 4 dimensions. The first dimension, D1, refers to OESC components and processes to facilitate its management (Figure 9). These components and processes have the capacity to analyze data, understand learners' demands and transform this information into knowledge. For example, when a learner formulates a demand, processes are activated to suggest a choice of several paths, showing in real time the differences amongst them (e.g. language, domain, level, design, underpinning values, overall objective in terms of quality understood as educating citizens for the knowledge society, etc.).

The second dimension, D2, refers to OE stakeholders and needed infrastructure. It addresses core components of learning (e.g. pedagogy, resources, knowledge and skills development), learners (i.e. responsible citizen) and learning providers (e.g. institutions, communities, individuals, businesses) on one hand. On the other, it addresses core components of learning infrastructure (e.g. policies, legal frameworks, technological infrastructure). This is where Open education practice come into play – from admission to certification, through open educational resources or open source software (e.g. Burgos, 2020; Cronin, 2020; García-Holgado et al., 2020; Weller, 2020; Wiley, 2017). This dimension is highly interactive and agile. Stakeholders who deliver learning, those who evaluate competences and knowledge, those who certify and all the remaining stakeholders within this huge and complex network must act according to open values, be accountable and acknowledged as competent bodies across landscapes - market, commons the state and any emergent actor.

The third dimension, D3, refers to the Open Ecosystem. This refers to the remaining opens with which education interacts, namely Open Science which is the closest to education; open galleries, libraries, archives, museums (GLAM); open government; open institutions; or open enterprises (Stacey, 2018).

The fourth dimension, D4, refers to digital and physical flows. It captures the myriad of individual learning paths supported and empowered by the underlying previously described 3 dimensions. This flow leverages citizens in the knowledge society to contribute to the building of a collective human intelligence.

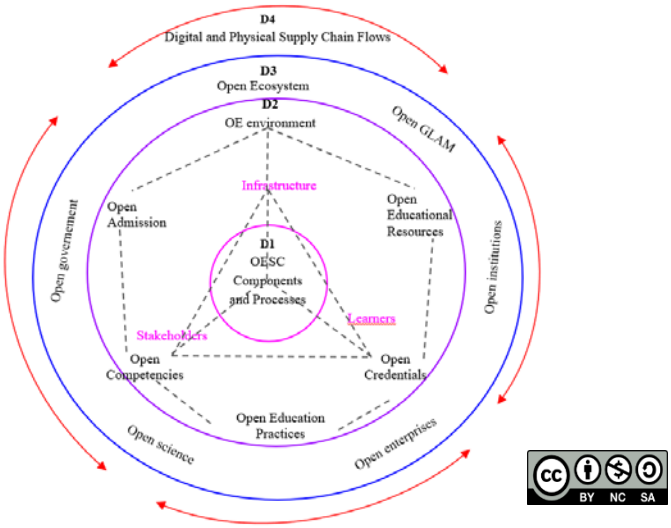

Fig. 9. Representing visually the Open Education Supply Chain, inspired from (Garay-Rondero et al., 2019)

6.4 Zooming in to highlight the paradigm shift

This was to give a picture of the overall structure. If we zoom at it and look at the different links of the OESC, from admission to certification, we can say that in the current paradigm, public or private institutions accredited by state, market or GAFAM are those who have the status to decide.

In the open paradigm, communities and ignored actors join in to decide and this changes obviously the entire game. Instead of having an administrative office, in a given institution, checking whether a learner has the required diplomas to start a given training, imagine that a learner can rely on diverse communities asserting, in the form of open credentials, that he or she has such and such competences and knowledge. Able to transform this information into knowledge, the learner takes the responsibility to enroll in a given training, estimating that he or she has the necessary prerequisites. Should it not be the case once the learning journey has started, he or she has the responsibility to take a decision, e.g. find support because the gap is within his or her zone of proximal development or change his or her learning route.

This is the current admission situation in MOOCs. No pass, in the form of previous diploma, is required to attend training. It is the responsibility of the learner to evaluate whether a given training is good for him or her, fix what he or she wants to get out of it (e.g. certification, network of interested persons, resources, etc.) and decide how to go about it.

The paradigm shift occurs at this very level. There is a shift in responsibility and decision taking. It is no longer the institution that tells a learner what to learn and whether he or she is admissible. In a landscape where no pre-designed curricula exist,

it is the learner's responsibility to take decisions and make choices. A second shift, when enrolling in a training, consists, as a learner, in deciding about clear objectives and then co-designing the actual learning adventure in a participatory manner with the teaching agents.

It is important to remember that open values are among others about participation, experience, agency and empowerment. Thus, teaching agents' values in the education setting should be outstanding mastery in their respective domains to allow for flexibility and co-design, at each and every step of the learning journey. Time for predefined "educational products" ready to be consumed is over and the maker movement is a good example for this (Mersand, 2021). Learners want to take the control of their path to develop knowledge and skills with full creativity and responsibility.

6.5 Visualizing the OESC at a micro level

To better figure out trajectories of individuals and communities in OESC, a first visual representation captures the process at an individual level (Figure 10). The learner takes on several roles simultaneously in different spaces – in this example, roles are learner in programming, teacher in Math's and community member in a Fablab. He or she is in interaction with other citizens in all these activities. Each of these individuals evolves in an open ecosystem, making use, adapting, creating and making available OER, soliciting and solicited within citizen science projects, and using open-source software.

Combining this individual layer with the representation of OESC (Figure x above) and adding social, economic, political and other dynamic forces to it, produces a complex network (Figure 11). It can not be captured visually with all its dynamics at this point but represents work to be conducted in the future with relevant case studies to gain further insights.

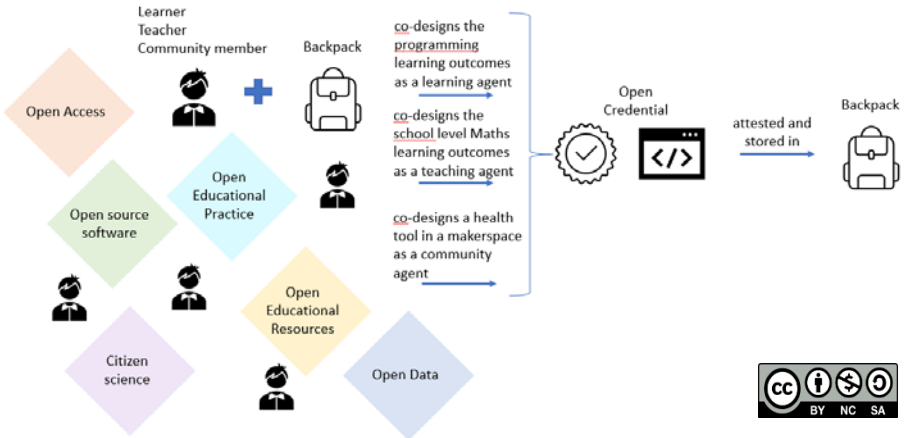

Fig. 10. Focusing on an individual trajectory in an Open Education supply chain

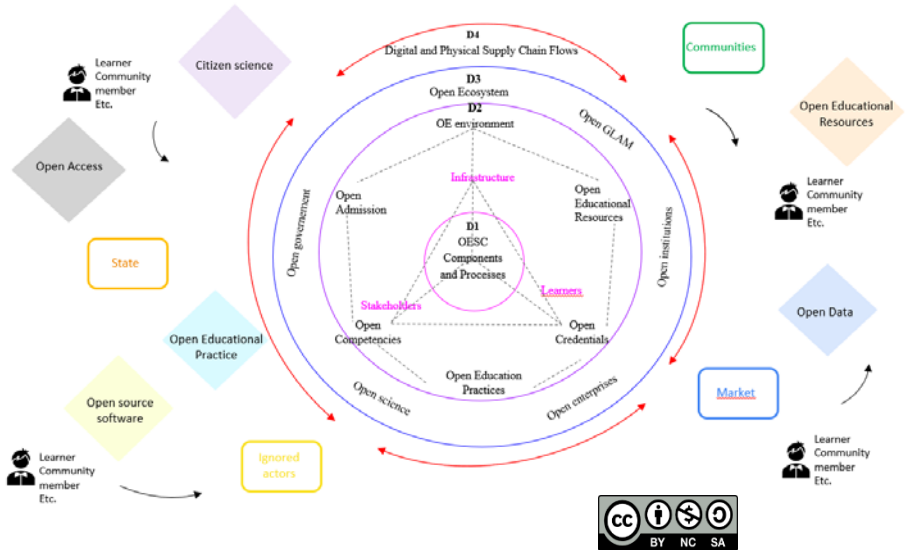

Fig. 11. A glimpse into the dynamics of OESC network

7 Discussion and conclusion

A knowledge society is a society that has to be invented (Innerarity, 2015) and in which value creation in terms of knowledge, as a raison d'être is core. Policies (UNESCO, 2020a) have acknowledged this and act as guidelines for citizens. The Open movement offers a sustainable framework (e.g. Creative Commons) for citizens to take their responsibility and creatively make these policies a reality in everyday life.

In this article we have tried to contribute to modelling Open Education supply chain as a network. A network of citizens and communities who turn in turn co-produce, co-design, participate actively and meaningfully (i.e. they are not passive consumers of pre-packaged products that are monetised). They contribute to the creation of common goods that take multiple forms. They contribute to the building of a human collective intelligence as an active node in the network who can demonstrate multiple skills and knowledge and flexibly switch roles in an open ecosystem.

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