



Review Article

Approaches to Innovative Learning Ecosystem

Do Hong Cuong, Nguyen Van Tuan,
Dinh Thi Kim Thuong, Nguyen Thi Kim Son*

Hanoi Metropolitan University, 98 Duong Quang Ham, Quan Hoa, Cau Giay, Hanoi, Vietnam

Received 20 April 2022

Revised 18 November 2022; Accepted 18 November 2022

Abstract: The article presents an overview of some recent studies on the domestic and international learning ecosystem and smart learning ecosystem. There is the need to build the foundation of an innovative learning ecosystem based on association theory that is suitable for the educational environment in Vietnam. The components of the learning innovation ecosystem are created with a close relationship among them. The article explores the role, meaning and impact of the innovative learning ecosystem on students, teachers, administrators, schools, and society. article.

Keywords: Learning ecosystem, education ecosystem, smart education ecosystem, innovative learning ecosystem, connectivism theory, educational technology.

1. Introduction

In recent times, the phrase "educational ecosystem" is frequently mentioned with different models such as *smart education ecosystem*, *creative education ecosystem*, *startup education ecosystem*, etc. According to Sean Slade, in education, the elements have separate roles and are interconnected [1]. So how is "connection" understood? According to OECD 2019, this means that all elements are linked together, without any superfluous elements, and all are related to each other [2].

The development of education is greatly influenced by social changes. especially the

impact of the 4.0 revolution and the formation of the knowledge society 2.0. Thereby promoting the development of an innovation ecosystem [3]. The fundamental difference between knowledge society 2.0 and knowledge society 1.0 is that education is geared towards building a Learning Society and Lifelong Learning. Therefore, learning and knowledge production need to be organized in the context of more social interaction [4, 5]. In this sense, an innovation ecosystem is a system whose core elements are highly interdependent and interconnected., comparable to complex relationships between organisms in a biological system [6].

Especially, in a period of crisis, as we have experienced in recent years (COVID-19 pandemic), education managers must provide a continuously renewed learning environment to

* Corresponding author.

E-mail address: ntkson@daihocthudo.edu.vn

<https://doi.org/10.25073/2588-1159/vnuer.4671>

help students and teachers adapt to circumstances and overcome difficulties. To provide continuous learning and innovative environments for students, schools or educational organizations need to build their ecological systems. The learning ecosystem helps the school fight crisis and create long-term benefits for students, staff, and teachers by promoting creativity and innovation, thereby improving the quality of the entire education for the student.

This article approaches to research on the views and models of the creative education ecosystem and the creative learning ecosystem of scholars. On that basis, we systematize the theory, methodology, or experience for building a model of an innovative learning ecosystem in Vietnam. In this article, we study the innovation ecosystem based on the smart education ecosystem with innovative attributes that affect all the ecosystem components. The necessity, meaning, and structure of the ecosystem are detailed in section 4. At the same time, the meaning and the role of the ecosystem described for students, teachers, educational managers, schools, and society are also discussed in detail in the last section (Section 5) of this article.

2. Methods

The article uses the method of analyzing research documents on the education ecosystem, the learning ecosystem, the creative education ecosystem, and the smart education ecosystem. Secondary data sources are research articles found on Google Scholar and the Internet, the search keywords used "Learning Ecosystem", "Learning Ecology", "Innovation Ecosystems", Innovative Education Ecosystem, smart education,... from subkeys are "overview" and "review",... The surveyed websites are all official websites of educational institutions.

Searching on Google Scholar by the keywords "Learning Ecosystem" and "Innovation Ecosystems" with the above criteria yielded a large number of articles. The

articles present an approach to research the education ecosystem, and the creative learning ecosystem in many aspects and many different environments. These studies are the premise for us to compare and approach research on the innovative learning ecosystem model suitable for Vietnam.

Searching on the Internet by keywords "Learning Ecosystem" and "Innovation Ecosystems", we have access to information from many conferences around the world on this issue, websites of many educational research organizations interested in the issue such as ASCD, OECD,... Especially, the Education Ecosystem innovations website is a place to share educational innovation information recognized as well as innovation achievements from the worldwide educational community.

3. Education as an Ecosystem

There are many perspectives on approaching education research as an ecosystem, in this article, we review it in two main directions: economics and technology.

3.1. Approach Towards Economic Research

Derived from the business ecosystem concept, the innovation ecosystem concept was first proposed by Moore in 1993. He believes that a company is not an individual but a part of a business ecosystem [7]. Ecosystems include many industries. They collaborate and compete to jointly develop new products that meet customer needs and ultimately work together to continue the next cycle of innovation. Thus, the term business ecosystem can be understood as innovation ecosystem [8, 9]. Another concept that is also mentioned with the meaning of innovation ecosystem is the knowledge ecosystem [10]. Valkokari [11] distinguishes three types of ecosystems: business ecosystems, knowledge ecosystems, and innovation ecosystems based on the value they create, respectively, customer value; knowledge and technology; creation and development. This classification has not shown the complex elements of the system as a whole as well as the

interactions between them. In particular, the role of context, institutions, cultural environment, and social standards has not been seen.

According to N. Smorodinskaya et al., [12], the innovation ecosystem differs from the business ecosystem in value co-creation. Taking this same view, but from a broader perspective, Carayannis and his team argue that value co-creation is not just the relationship between the producer and the customer, but also between many other actors [13]. Summarizing the views on the innovation ecosystem, Cai and his colleagues believe that What's new in the innovation ecosystem is its ecological aspect, which is characterized by the interdependence between different cooperative actors and the co-evolution/co-creation that binds them together over time. time, together with the sustainable development aspect [14]. Lee et al., also mentioned the “co-innovation” network when studying the innovation ecosystem [15].

From an overview of ecosystem concepts, Yuzhuo Cai and his colleagues argue that “an innovation ecosystem is a co-innovation network in which actors from organizations are involved in the knowledge production function. Knowledge, wealth creation, and control norms interact in forming co-evolutionary and interdependent relationships (both directly or indirectly) in the cross-geographical context and through which ideas new ideas and approaches from different internal and external sources are integrated into one platform to create common values for the sustainable transformation of society” [16]. In this definition, Yuzhuo Cai's research group has pointed out the comprehensiveness of the actors in the innovation ecosystem and the linkage between them, especially the impact of indirect relationships.

However, up to now, there is not enough concept for us to understand the whole system and the relationships in the innovation ecosystem. A conceptual or theoretical framework for elucidating the nature and dynamics of innovation ecosystems is needed.

3.2. Research in the Field of Technology

The development of technology is happening rapidly and has an impact on the whole of society, especially in education. Most modern educational models are largely influenced by technology. Research on educational technology was started very early.

In the mid-1990s at the Center for Creative Leadership in North Carolina, Morgan McCall and colleagues developed the 70:20:10 research model. Their research has shown that: 70% of the learning occurs when learners participate in unofficial learning processes such as observing others, participating in habits at living places and workplaces, and performing challenging tasks; 20% arising from advice, advice, and training (mainly from managers or supervisors); 10% is the result of official courses and reading. Study model 70:20:10 simply explains how learning takes place in the workplace, that learning not only occurs in courses and learning needs highly experiencing [17]. Ecosystem thinking is a means for educational managers to bring the model 70:20:10 into reality. The learning ecosystem provides a means to beyond the design of courses and instead designs overall strategic approaches, integrated into the study.

According to the demand to expand the space and structure of learning, along with the ecological environment model, a series of technology environmental models for learning are some authors simultaneously given under the system concept Ecology learning - Learning Ecosystem. Author [18] uses the concept of the ecosystem from biology to define ecosystems, with Italy to study at work. The concept of digital ecosystems, E-Learning Ecosystem is used as computer network infrastructure on the Internet, E-Learning infrastructure [19].

Kseniya A. Elistratova, Irina A. Donina, and Tatyana G. Ryboretskaya argue that the main goal of innovation in the educational system is to update the content, form, methods, and technology [20]. Assessing the role of technology and digital in education, Alzhanat Suleimankadieva, Maxim Petrov¹, and Andrey Kuznetsov said that “Digital educational

ecosystem as a tool for the intellectual capital development” [21].

In a report by Valerie Hannon and his partners in 2019 [22] about the ecosystem, it is presented about the need, the models of ecosystems have been deployed in the world and views, watching an ecological learning system as an educational trend of the 21st century, is a way of changing education methods today and is a way for educational managers to apply. Accordingly, 09 ecosystem models have been applied in countries: USA, Australia, Russia, Spain, Finland, and England have been analyzed in detail and thoroughly in 107 pages of the report about the limited advantages and existence of these specific models. Since then the authors conclude that: "... The Movement Towards Learning Ecosystems is Full of Potential for A Transformation in How Learning Happens. But (AT LEAST AT This Level of Complexity) It Is In The Very Early Stages and Faces Formidable Challenges to Evolve Into A New Normal,... "AS A Field, It Is Still in ferment. Some Will Morph and Develop In As Yet Unpredictable Ways. The Need Now Is to Collect And Share Many Examples Of Initiatives In The Field, Particularly Those From The Global South" [23].

Recently, online teaching in Vietnam was deployed and increased in both quantity and quality. Many scientists mentioned learning ecosystems, online education ecosystems, and the elements that constituted them.

Author [24] in the approaching perspective of connection theory has shown: "Ecosystems include creature and non-physician components and all relationships in the physical boundary identified. Specifically, it includes stakeholders involved in the entire string of learning processes, learning utilities, learning environments, and in specific boundaries - learning environment boundaries".

In the project [25], the author follows and colleagues presented some of the first step results in Constructing Educational Ecosystem 4.0 at Ho Chi Minh City University of Technology and Education, in which the UTEX

4.0 educational system at HCMUTE was introduced, while proposing a feasible teaching design model to step by step operation of UTEX as an online component of UTE 4.0 into practice [26].

Some studies on online education ecosystems in view a system of stakeholders involved in the entire educational process with learning utilities, learning environments, and interactions. Connecting the use of information and communication technology is the author et al., Presentation in the work [27].

With the same approaching domestic and international models, authors in [28] have analyzed structures and elements that make up online education ecosystems, thereby proposing a theory of system ecology of online education and conditions to ensure online education ecosystem sustainable development, become a reliable platform, in parallel with national education systems in Vietnam.

The author in [29] has preliminarily described the approach of educational ecosystems, and elements; visualize some difficulties and convenience; criteria for quality assessment; an educational ecosystem model of Vietnam. Accordingly, an online educational ecosystem must also have three main components: i) Person (learners/supporters); ii) Environment (space E-Learning and resources; Line management system, e-learning content,...); and iii) Relationships/Contact (Culture E-Learning, Rules, Actions Compatible with the e-learning process, practitioner's interaction in online courses, policies, management,...). In addition, an effective educational ecosystem needs to have other important components such as i) Attractive content; ii) Review continuously; and iii) Modern technology, etc.

Thus, although there have been many studies on the learning ecosystem, education ecosystem, smart ecosystem, and online education ecosystem, at home and abroad in different directions. But the approach to the education ecosystem is open, between the smart ecosystem with openness and creativity; The relationship between the elements in the system has not been satisfactorily resolved.

This article develops the concept of an innovative learning ecosystem that is relevant to the educational environment in Vietnam. This ecosystem is built on an intelligent education platform, an innovative environment, and strong connectivity. This ecosystem will make the subjects participating in the educational process more active and flexible in the creative environment. Ecosystem stakeholders come together to get ideas, generated (creative content and innovative organization). The elements in the system all support the learning process. This system is synchronous, complete, and convenient and effectively applies information technology in management, organization of teaching, and connection with society; This meets the high demand in receiving and processing information,

improving the quality of education and public services.

4. Innovative Learning Ecosystem

According to the analysis of the research results of domestic and foreign authors (G. Siemens, 2009) [30], (N. M. Hung, 2012) [31], we go to the definitions of learning ecosystems and creative ecosystems as follows: A learning ecosystem is a system of learning people, learning content, technology, learning context, culture, and strategy, existing both within and outside of an organization, all of which have an impact on both the formal and informal learning that goes on in that organization (Figure 1).

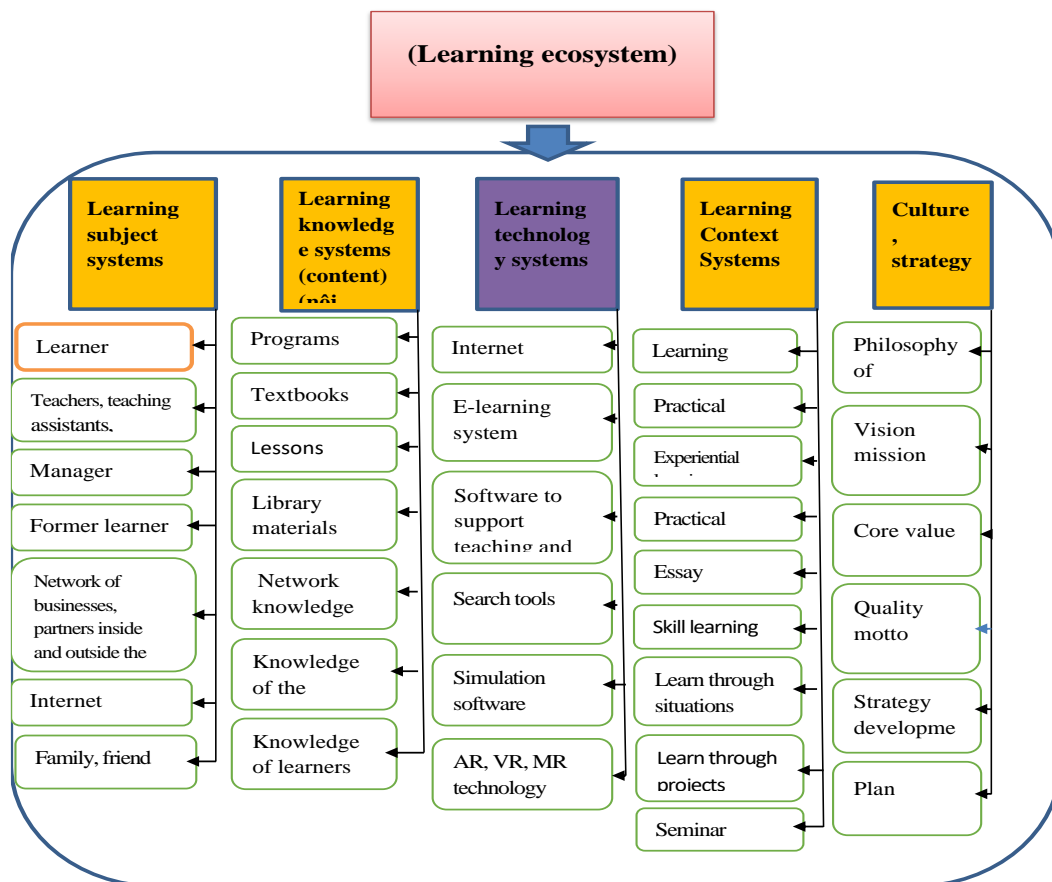


Figure 1. Innovative learning ecosystem model.
(Source: Authors)

In a learning ecosystem, creativity shows close connections between learning components that are associated with open links and far beyond the traditional concepts of teaching and learning in the school framework, in which creativity is the outstanding common characteristic of all elements in that ecosystem. The structure of the creative learning ecosystem can be described as follows:

i) Creative learning subject. The subject of learning includes groups or networks: learners, teachers, families, friends, business networks, partners in and out of schools, communities, society, etc. These groups and networks can form in key courses and extracurricular; Learning proactive, passive, formal and informal, etc. According to a connection perspective, the role of learners, and teachers in the system, the connection network is a mutual affiliate, that supports and changes each other depending on a specific situation. Creative characteristics are shown in the network of academic subjects;

ii) Flexible learning knowledge. The learning knowledge system includes programs, lectures, textbooks, and textbooks; electronic documents, network documents; Conference reports, seminar discussions, personal consultants, experienced management of an enterprise, etc. All of the content constitutes learning knowledge, built groups, actively transmitted from people who teach or receive automatically from learners through the network interactions of the system, have hybridization, complexes and interactions;

iii) Modern, creative learning technology. Learning technology systems include technology infrastructure, and technology platforms of ecosystems (schools, communities,...); The software connects elements in the ecosystem; Data Warehouse Number, LMS System, E-Learning Lecture System, Online Support Systems, Online Consultation with students and parents, science and technology clubs, innovative innovation in school, search engines/lookup on the Internet, simulation software, internet, etc.,...;

iv) Creative learning context. In a learning ecosystem, the learning context is understood as different forms of education: learning through play; learning through practice, and experience; Learning through situations; learning through the project; learning theory; Reality practice. In addition, the local cultural context of local, heritage, craft village culture, technology applications, science and technology in ecosystems, business systems connect, political organizations Social, social organizations, families, and other subjects of the ecosystem involved in the ecosystem, creating their learning context of that ecosystem;

v) Culture and strategy. Ecosystem learning systems are based on core platforms learning culture and core values. Decisions in the ecosystem must be carried out based on a strategic perspective. All components of the ecosystem are aimed at achieving the strategic objectives of the school/organization, local (places to locate), suitable for traditional local culture and culture, and the core value of the school.

The learning technology systems used to support the processing of synthetic information are designed to depend on the subject system of the learner - the teacher; into the specific context of the learning ecosystem, to the strategic culture of the school/educational institution, as well as to the knowledge system/related content in a flexible, innovative and creative way.

Therefore, the innovation ecosystem represents the close connection between the components in the system with each other and with the external learning environment (ecosystem within the ecosystem) through the connection of knowledge and technology environment flexibly and innovatively. It demonstrates individualization through the establishment of relationships to create an educational connection environment for personal development, improving learners' general and individual competencies, with emphasis on the ability to learn. creative force,

the ability to adapt to innovation, in line with the trends and mobilizing purposes of that educational ecosystem.

5. Discussion

Research on education 4.0, the position, role, and connection of actors in the education system have been mentioned in the research of many scholars through actual survey data in Malaysia [32], Ecuador [33], Turkey [34], China [35],... These results have suggested establishing actors' relationships in the innovation learning ecosystem.

With the high complexity of the learning environment, academic demand and post-graduate career competitiveness, and high dynamics of interaction among members of the learning community, technology resources, and services provided in a modern learning environment, are comparable to the situation in biological (living) ecosystems, shows the need for research to build a comprehensive ecosystem-based model to establish a learning ecosystem. Developing a learning ecosystem in the direction of an intelligent education ecosystem, creating a favorable environment to support a comprehensive educational process based on exploiting digital technology platforms; the creative attribute is a cross-cutting attribute that appears in the elements of the ecosystem. So how does the result of connecting and processing information affect subjects such as Principals, Schools, teachers, and learners in the educational process, we will discuss in detail this topic below.

So how do the results of that connection and information processing help the principal to make decisions? How help the school/educational organization in carrying out educational tasks?

Education 4.0 is defined as a technology-based teaching and learning method [36] so all education stakeholders must-have technology skills. Especially school administrators need to use technology effectively and keep up with the development of technology. The concept of

technology leadership, defined as being responsible for improving the interface between people and IT components [37], has become one of the most emphasized leadership styles. strength of the 21st century. Education managers are responsible for developing leadership and management strategies for integrating technology into schools [38]. In summary, school administrators have a responsibility to transfer and effectively use computers and related technologies in schools [39]. Another key element of education 4.0 is the use of learning analytics to predict students' future learning outcomes and maintain student continuous improvement [40]. In this sense, the ability of school administrators to interpret education data can be assessed as a skill that will facilitate the transition of schools to Education 4.0. Another skill mentioned for the school administrators of Education 4.0 is the skill of instruction. Puncreobutr (2016) [41] states that the core of education 4.0 is guiding students to develop their skills to use new technologies. It can be inferred that there is a guiding and mentoring perspective on the foundation of education 4.0.

To do this, education managers (such as Principals) need to build a learning ecosystem to i) Increase the participation of the team indirectly in the educational process, improve the ability of social supervision for activities education; ii) Increase the diversity of content and creative learning types; iii) Cut retraining costs while ensuring the overall quality of education; and iv) Strengthen innovation in schools, being able to flexibly adapt to the situation - especially in times of crisis. Ecosystem thinking provides a means for educational administrators to bring the 70:20:10 model to life. Learning ecosystems provide a means to go beyond designing courses and instead design more integrated, holistic strategic approaches to enhancing learning.

Principals should, in one form or another, approach building an innovative learning ecosystem for purposes and purposes that are larger and more expansive than conventional systems, normally available, including

engaging with real-life issues of society in a way that schools cannot do independently (e.g. moral education, cultural education, social issues festival, etc).

The application of Information and Communication Technology and smart technology devices is extensive and impregnated in school activities, which increases interaction, expands connections, improves teaching and learning quality, and increases efficiency, and school management. The school becomes a cell, an important link in the world connected with schools, other learning institutions, and the community at large.

Learning Ecosystems help educational organizations/schools cope with the crisis and create long-term benefits for students by fostering creativity and innovation, which in turn affects the quality of education as a whole. As the conclusion of the WISE Report: the learning ecosystem is the educational trend of the 21st century, and the way to change today's educational methods and the way for administrator's education should apply.

How do the results of the connection and processing of information in the innovative learning ecosystem help teachers in carrying out their educational tasks?

Talking about the teacher in education 4.0, Kilic (2018) pointed out that the mentor teacher would replace the classical authoritarian teacher because of the large number of information students have to access today [42]. Therefore, it is suggested that the teacher of Education 4.0 should be the guide for students to access and benefit from this new information [43]. As a result, students will be able to distinguish true and false information from unlimited sources of information. Teachers also need to focus on guiding students to set learning goals to suit themselves. With this guidance, students can focus on their abilities and goals in life, and teachers can provide them with personalized educational opportunities outlined in the education standards. 4.0 [44]. Abersek and

Flogie (2018) also pointed out that personalized education in Education 4.0 could be achieved through the use of technology and innovative pedagogy and that each student should be guided individually [45].

In innovative learning ecosystems, teachers have a dual role: providing knowledge, providing feedback to students on their academic performance, and leading conversations that encourage reflective thinking and learning. A modern learning environment must support terminals, media, sources, and services. Teachers and students must have the freedom to choose learning tools and content in the learning process, wherever they are. Furthermore, learning must be contextualized and linked to other processes of everyday life.

As a result, teachers will learn skills, with new roles and new circumstances, adapting to technology and students active and creative learning. Through teachers' extensive skills in relating and working with students or other partners, or in creating new roles (traffic safety guide, connector), innovation, creativity, and breakthrough will require teachers in new roles. Many of the teachers will take on jobs and roles that have never been done before. Therefore, teachers not only have to renew their teaching plans, but also have to innovate and perfect themselves, teaching methods, and ways of interacting and transmitting knowledge, to participate in the ecosystem with different roles in each situation.

How does the result of this connection and information processing help learners improve learning efficiency and improve creativity?

The innovative learning ecosystem offers a way to make students more adaptive and flexible. Specifically, it allows learners to actively choose content and learning methods actively and creatively; personalize the learning process. Learners will orient themselves when at the center of the ecosystem. This self-direction includes self-identification of learning needs and self-assessment/self-funding of necessary support and resources/practice of knowledge and skills and receiving feedback

on effectiveness/perception and reflecting on what has been learned/evaluating one's own learning process.

The innovative learning ecosystem includes a network of connections, powered by technology that allows students to work directly with teachers, and educators, and to interact among students in meaningful engagements. Meaningful, targeted, with creative ways and thinking, leading to a better grasp of subject content. That network breaks the concept of traditional classrooms with fixed timetables and the old ways of thinking about education to direct learners to join flexible learning groups that are tailored to their needs and their demand. In this process, the teacher acts as a guide to guide students to develop personalized learning abilities during direct interaction with students (in class) or indirectly (through study groups on the media). In the interaction of those factors, the roles and modes of operation of students, teachers, leaders, and school administrators have changed, different from traditional schools. Student-centered and supported, enabling intelligent learning development. Learning in an environment that brings together many aspects of a learning ecosystem - learners need to have learning goals, creative thinking, and a desire to learn from friends, teachers, and the community; with access to the right knowledge and support, higher learning outcomes are achieved.

This model seems to have a similarity to the flip class concept [46]. In the flip-flop classroom, students can learn lesson-related digital resources such as videos, presentation materials, and electronic materials outside of school, and they can gather the knowledge they need from the classroom. traditional. Thus, students can use class time for activities such as discussion, analysis, and problem-solving. The flip class can be accepted as a blended learning process as this model uses online learning materials while transforming traditional classrooms and enhancing the educational process with these materials.

One of the changes in the learning and creative ecosystem is the emphasis on the role

of the school - especially the choice and central voice of the school in social issues related to education. Not only have new opportunities and pathways been created, but it has also allowed learners to actively decide how they will learn and grow.

In addition, the serious participation of businesses, the cultural sector, and many other sectors create opportunities for students to innovate in holistic educational thinking. Learners will learn more effectively when teaching activities in schools are guided by the right strategy and a healthy culture. A learning and creative ecosystem that contributes to educating people for comprehensive development and making the best use of each individual's potential and creative ability.

The path to learning transformation through an Innovative learning ecosystem includes: First, creating a new personalized learning culture; Second, allowing for the development of diverse learning structures; Third, developing human capital for a personalized learning ecosystem; Fourth, developing a new data infrastructure, focusing on learners; Fifth, allow new forms of assessment and alternative certifications; Sixth, allow creativity in approaches; Seventh, allow businesses and organizations outside the school to participate in the educational process; Eighth, there is a development strategy, quality motto, and core values announced to the society. All of the above factors are built on the foundation of modern technology; consistent with the guidelines and policies of the educational institution, the local culture, and the educational development strategy of the locality, province, and city.

6. Conclusion

Humans are the owners of creation, the driving force for creation to form and develop, and people are also the objects of creation. Therefore, with the desire for sustainable creativity, we need to have creative citizens, master and elevate creativity starting with children who are educated creatively. By

attaching importance to the education of creative abilities for students, and creating opportunities for creativity to be developed in education and science; the creative learning ecosystem will form a young workforce that will be the subject of social creativity in the future. The learning and creative ecosystem create a developed workforce based on productivity and efficiency, based on intellectual capacity and creativity, and innovation of people. Therefore, contributing to building the premise of improving the creativity of society and developing the knowledge economy.

References

- [1] S. Slade, Education is an Ecosystem, American Society for Monitoring and Program Development (ASCD) Blog, July 8, 2019.
- [2] OECD, Future of Education and Skills 2030, Concept Note: Knowledge for 2030, <https://www.oecd.org/education/2030-project/>, 2022 (accessed on: October 18th, 2022) (in Vietnam).
- [3] L. A. V. Gomes, A. L. F. Facin, M. S. Salerno, R. K. Ikenami, Unpacking the Innovation Ecosystem Construct: Evolution, Gaps and Trends, *Technological Forecasting and Social Change*, Elsevier, Vol. 136(C), 2018, pp. 30-48, <https://doi.org/10.1016/j.techfore.2016.11.009>.
- [4] H. Tsoukas, A Dialogical Approach to the Creation of New Knowledge in Organizations, December 2009, *Organization Science*, Vol. 20, No. 6, 2009, pp. 941-957, <https://doi.org/10.1287/orsc.1090.0435>.
- [5] S. K. Muthusamy, M. A. White, Learning and Knowledge Transfer in Strategic Alliances: A Social Exchange View, *Organization Studies*, Vol. 26, No. 3, 2005, pp. 415-441, <https://doi.org/10.1177/0170840605050874>.
- [6] D. S. Oh, F. Phillips, S. Park, E. Lee, Innovation Ecosystems: A Critical Examination, *Technovation*, Vol. 54, 2016, pp. 1-6, <https://doi.org/10.1016/j.technovation.2016.02.004>.
- [7] J. F. Moore, Predators and Prey: A Newecology of Competition, *Harvard Business Review*, 1993, pp. 75-86.
- [8] H. Overholm, Collectively Created Opportunities in Emerging Ecosystems: The Case of Solar Service Ventures, *Technovation*, Vol. 39-40, No. 1, 2015, pp. 14-25, <https://doi.org/10.1016/j.technovation.2014.01.008>.
- [9] P. Ritala, V. Agouridas, D. Assimakopoulos, Value Creation and Capture Mechanisms in Innovation Ecosystems: A Comparative Case Study, *International Journal of Technology Management*, Vol. 63, No. 3+4, 2013, pp. 244-267, <https://doi.org/10.1504/IJTM.2013.056900>.
- [10] B. Clarysse, M. Wright, J. Bruneel, A. Mahajan, Creating Value in Ecosystems: Crossing the Chasm Between Knowledge and Business Ecosystems, *Research Policy*, Vol. 43, No. 7, 2014, pp. 1164-1176, <https://doi.org/10.1016/j.respol.2014.04.014>.
- [11] K. Valkokari, Business, Innovation, and Knowledge Ecosystems: How They Differ and How to Survive and Thrive within Them, *Technology Innovation Management Review*, Vol. 5, No. 8, 2015, pp. 17-24, <http://timreview.ca/article/919> (accessed on: October 18th, 2022).
- [12] N. Smorodinskaya, M. G. Russell, D. Katukov, K. Still, Innovation Ecosystems vs. Innovation Systems in Terms of Collaboration and Co-creation of Value, *Proceedings of 50th Hawaii International Conference on System Sciences*, 2017, pp. 5245-5254.
- [13] E. G. Carayannis, E. Grigoroudis, D. F. J. Campbell, D. Meissner, D. Stamati, The Ecosystem as Helix: An Exploratory Theory-building Study of Regional Co-opetitive Entrepreneurial Ecosystems as Quadruple/Quintuple Helix Innovation Models, *R&D Management*, Vol. 48, No. 1, 2018, pp. 148-162, <https://doi.org/10.1111/radm.12300>.
- [14] Y. Cai, B. R. Ferrer, J. L. M. Lastra, Building University-Industry Co-Innovation Networks in Transnational Innovation Ecosystems: Towards a Transdisciplinary Approach of Integrating Social Sciences and Artificial Intelligence, *Sustainability* Vol. 11, No. 17, 4633, 2019, pp. 1-23, <https://doi.org/10.3390/su11174633>.
- [15] S. Lee, D. L. Olson, S. Trimi, Co-innovation: Convergenomics, Collaboration, and Co-creation for Organizational Values, *Management Decision*, Vol. 50, No. 5, 2012, pp. 817-831, <https://doi.org/10.1108/00251741211227528>.
- [16] Y. Cai, J. Ma, Q. Chen, Higher Education in Innovation Ecosystems, *Sustainability*, Vol. 12, No. 11, 4376, 2020, pp. 1-12, <https://doi.org/10.3390/su12114376>.
- [17] M. Lombardo, R. Eichinger, *The Career Architect Development Planner* (1st ed.), Lominger Limited, 1996 (in USA).
- [18] M. Berthelemy, Definition of a Learningecosystem, Main Blog,

- <https://web.archive.org/web/20160412174337/http://www.learningconversations.co.uk/main/index.php/2010/01/10/the-characteristics-of-a-learning-ecosystem?blog=5> (accessed on: October 18th, 2022) (in Vietnam).
- [19] C. Guetl, V. Chang, Ecosystem-based Theoretical Models for Learning in Environments of the 21st Century, *International Journal of Emerging Technologies in Learning (IJET)*, Vol. 3, No. 1, 2008, pp. 50-60, <https://doi.org/10.3991/ijet.v3i1.742>.
- [20] K. A. Elistratova, I. A. Donina, T. G. Ryboretskaya, Formation and Development of the Ecosystem of Innovative Education in the Region, *Proceedings of International Scientific and Practical Conference Strategy of Development of Regional Ecosystems "Education-Science-Industry"*, 2021, pp. 118-122.
- [21] A. Suleimankadieva, M. Petrov, A. Kuznetsov, Digital Educational Ecosystem as a Tool for the Intellectual Capital Development, *SHS Web of Conferences* 116, 00060 ICSR, 2021, pp. 1-7.
- [22] V. Hannon et al., *Local Learning Ecosystems: Emerging Models*, WISE-2019.
- [23] OECD, *Future of Education and Skills 2030, Concept Note: Knowledge for 2030*, <https://www.oecd.org/education/2030-project/>, 2022 (accessed on: October 18th, 2022) (in Vietnam).
- [24] N. M. Hung, Learning Ecosystem - The View from Connectivism and System Theory, *Journal of science of HNUE Education Science*, Vol. 58, No. 4, 2013, pp. 34-44.
- [25] N. A. Tuan, P. X. Thanh, M. A. Tho, The Initial Result in Constructing Education Ecosystem 4.0 at Ho Chi Minh City University of Technology and Education, *Journal of Science and Technology Education*, No. 54, 2019, pp. 100-107.
- [26] N. M. Hung, From the Learning Connectivism Theory to Suggest the Application of Technology in Learning, *Journal of Science of HNUE Education Science*, Vol. 57, No. 9, 2012, pp. 68-77.
- [27] N. M. Huong, T. T. L. Thu, Online Education Ecosystem and Quality Assurance Requirements - experiences of Hanoi Open University, *Hanoi Open University Journal*, Vol. 74, 2020, pp. 1-10.
- [28] N. M. Huong, T. T. L. Thu, N. H. Duc, An Online Education Ecosystem Vietnam *Science Education Journey*, Special Number, 2021, pp. 12-19.
- [29] P. D. Quang, Education Ecosystem: Name and Approach Vietnamese *Science Education Journey*, Special Number, 2021, pp. 20-25.
- [30] G. Siemens, New Structures and Spaces of Learning: The Systemic Impact of Connective Knowledge, Connectivism, and Networked Learning, *Universidade Do Minh, Encontro Sobre Web 2.0*, 2009.
- [31] N. M. Hung, From the Learning Connectivism Theory to Suggest the Application of Technology in Learning, *Journal of Science of HNUE Education Science*, Vol. 57, No. 9, 2012, pp. 68-77.
- [32] T. M. Kin, A. K. Omar, K. Musa, A. M. Ghouri, Leading Teaching and Learning in the Era of Education 4.0: The Relationship Between Perceived Teacher Competencies and Teacher Attitudes Toward Change, *Asian Journal of University Education (AJUE)*, Volume 18, No. 1, 2022, pp. 65-80, <https://doi.org/10.24191/ajue.v18i1.17171>.
- [33] M. S. R. Montoya, M. I. L. Aguirre, A. Z. Ojeda, M. P. Castro, Characterization of the Teaching Profile within the Framework of Education 4.0, *Future Internet*, Vol. 13, No. 91, 2021, pp. 1-17, <https://doi.org/10.3390/fi13040091>.
- [34] B. Himmetoglu, D. Aydug, Dr. C. Bayrak, Education 4.0: Defining the Teacher, the Student, and the School Manager Aspects of the Revolution, *Turkish Online Journal of Distance Education-TOJDE, IODL-Special Issue Article 2*, 2020, pp. 12-18, ISSN 1302-6488.
- [35] Y. Cai, J. Ma, Q. Chen, Higher Education in Innovation Ecosystems, *Sustainability*, Vol. 12, No. 4376, 2020, pp. 1-12, <https://doi.org/10.3390/su12114376>.
- [36] A. Hariharasudan, S. Kot, Scoping Review on Digital English and Education 4.0 for Industry 4.0, *Social Sciences*, Vol. 7, No. 227, 2018, pp. 1-13, <https://doi.org/10.3390/socsci7110227>.
- [37] D. Scanga, *Technology Competencies for School Administrators*, Unpublished Dissertation of Doctor of Philosophy, Florida, USA: South Florida University, 2004.
- [38] C. H. Weng, Y. Tang, The Relationship Between Technology Leadership Strategies and Effectiveness of School Administration: An Empirical Study, *Computers & Education*, Vol. 76, 2014, pp. 91-107, <https://doi.org/10.1016/j.compedu.2014.03.010>.
- [39] S. Turan, *Teknolojinin Okul Yonetiminde Etkin Kullaniminda Egitim Yoneticisinin Rolu*, *Kuram Uygulamada Egitim Yonetimi*, Vol. 30, No. 30, 2002, pp. 271-281.
- [40] M. Ciolacu, A. F. Tehrani, R. Beer, H. Popp, Education 4.0 - Fostering Student's Performance with Machine Learning Methods, *IEEE 23rd International Symposium for Design and Technology in Electronic Packaging (SIITME)*, Constanta, Romania, 2017, pp. 438-443, <https://doi.org/10.1109/SIITME.2017.8259941>.

- [41] V. Puncreobutr, Education 4.0: New Challenge of Learning, *St. Theresa Journal of Humanities and Social Sciences*, Vol. 2, No. 2, 2016, pp. 92-97.
- [42] T. Kilic, *Hezarfen Egitim Modeli*, Istanbul: AZ Kitap, 2018.
- [43] T. Wallner, G. Wagner, *Academic Education 4.0*, International Conference on Education and New Developments, Ljubljana, 2016, pp. 155-159.
- [44] B. Abersek, A. Flogie, Evolution of Competences for New Era or Education 4.0, XXV Conference of Czech Educational Research Association (CERA/CAPV) Impact of Technologies in the Sphere of Education and Educational Research, Czech, 2017.
- [45] C. A. Youngkin, The Flipped Classroom: Practices and Opportunities for Health Sciences Librarians, *Medical Reference Services Quarterly*, Vol. 33, 2014, pp. 367-374, <https://doi.org/10.1080/02763869.2014.957073>.
- [46] B. Himmetoglu, D. Aydogu, Dr. C. Bayrak, Education 4.0: Defining the Teacher, the Student, and the School Manager Aspects of the Revolution, *Turkish Online Journal of Distance Education-TOJDE, IODL-Special Issue Article 2*, 2020, pp. 1302-6488.