



# Seven Possible Characteristics of the Education 4.0 Teacher

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## ABSTRACT

**Background:** In the current context, numerous technologies are available, and access to information is facilitated to all who have access to the Internet. Education 4.0 emerged as a response to the need to meet the demands that will undoubtedly arise with the way society has been developing in the direction of the so-called Innovation Society. **Objectives:** The objective of this work was to elaborate a model of the Education 4.0 teacher, integrating Siemens' Connectivist Theory with Papert's Constructionism. **Design:** The methodology used here consisted of the textual analysis of the primary sources of Siemens' Connectivist proposal and Papert's Constructionism, aiming to identify characteristics that can lead the teacher of Education 4.0. **Environment and participants:** The primary sources of Siemens' Connectivist proposal and Papert's Constructionism, as it is a bibliographic theoretical study. **Data collection and analysis:** Data were collected from the mentioned primary sources and analysed by textual analysis. **Results:** As a result, seven possible characteristics of the Education 4.0 teacher were identified: Mediator, Researcher, Adaptive, Mentor, Apprentice, Bricoleur, and Self-reflective. However, the survey carried out by digital means with 30 active and non-active teachers revealed that 53.3% were unaware of the concept of Education 4.0. **Conclusions:** It was concluded that teachers need continuing education courses to develop the pedagogical praxis of education 4.0. **Keywords:** Connectivism; Constructionism; Education 4.0; 21st Century Society; continuing teacher education.

## Sete Possíveis Características do Professor da Educação 4.0

## RESUMO

**Contexto:** No contexto atual, numerosas formas de tecnologias se encontram disponíveis e o acesso à informação é facilitado a todos os que têm acesso à Internet. A

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Educação 4.0 surgiu como a resposta à necessidade de atender às demandas que surgirão, certamente, com a forma que a sociedade vem se desenvolvendo na direção da chamada Sociedade da Inovação. **Objetivos:** O objetivo deste trabalho foi, assim, elaborar um modelo do Professor da Educação 4.0, integrando a Teoria Conectivista de Siemens com o Construcionismo de Papert. **Design:** A metodologia utilizada aqui consistiu na análise textual das fontes primárias da proposta Conectivista de Siemens e do Construcionismo de Papert, objetivando identificar características que possam conduzir o professor da Educação 4.0. **Ambiente e participantes:** As fontes primárias da proposta Conectivista de Siemens e do Construcionismo de Papert, por se tratar de um estudo teórico bibliográfico, **Coleta e análise de dados:** os dados foram coletados das fontes primárias mencionadas e analisados por análise textual. **Resultados:** Como resultado, identificaram-se sete possíveis características do professor da Educação 4.0: Mediador, Pesquisador, Adaptativo, Mentor, Aprendiz, Bricolador e Autorreflexivo. No entanto, pesquisa realizada por meios digitais com 30 professores, dentre atuantes e não atuantes, revelou que 53,3% deles desconheciam o conceito de Educação 4.0. **Conclusões:** Concluiu-se pela necessidade de cursos de formação continuada de professores para o desenvolvimento da práxis pedagógica da educação 4.0.

**Palavras-chave:** Conectivismo; Construcionismo; Educação 4.0; Sociedade do Século XXI; formação continuada de professores.

## INTRODUCTION

In the current context, numerous technologies are available, and access to information is facilitated to all who have access to the Internet. With this in mind, one could think that the teacher's figure has become expendable in the process of knowledge construction by children and adolescents.

There is a growing increase in Internet access and the use of social networks and applications in general, primarily through smartphones, which may be directly linked to the costs of these technologies continually decreasing (Gantz & Reinsel, 2012, p. 2).

However, easy access to information does not necessarily imply that students can follow society's progress. In fact, although surrounded by the so-called digital culture, the use of technologies by children and adolescents remains restricted (Bennett & Maton, 2010; Desmurget, 2020).

At the beginning of the 21st century, Marc Prensky (2001a) coined the term *digital natives*, arguing that today's young people would not be the same as those in the past, considering that their thought patterns have changed as a result of being born/grown up immersed in a changing world. Increasingly sophisticated digital technologies prevail, being used to receive information quickly, and possessing multitasking skills (Prensky, 2001b). However, we

have already challenged this idea, arguing that, instead, we all go through repeated processes of ‘immigration’ to the new technologies that continually emerge (dos Santos & Lemes, 2020).

It was shown that most students still make little use of the technological resources they have for matters not merely related to entertainment (dos Santos & Lemes, 2020). This is even more evident when parameters such as the socioeconomic or geographical situation of the students are included in the discussion, which makes it clear that access has become universal in quantitative rather than qualitative terms. There are still severe gaps to be filled that also depend on adequate teacher preparation, aiming to contribute to overcoming the so-called digital exclusions (dos Santos et al., 2019, 2020), which were even more evident during the COVID-19 pandemic.

It is not enough for students to know how to carry out ‘research’ on the Internet, which often boils down to just basic searches for simple terms, generally ignoring more appropriate terms to address their doubts and needs effectively. In addition, they often do not know how to interpret correctly the results returned, as they believe that it is possible to find everything in the Google search engine without considering the credibility of the information found, as Antunes and Seguro de Carvalho warn (2015).

As we have already stated, by denying its students institutional access to the Internet and due social support to those less fortunate, the Brazilian school system has failed to play its crucial role in cultivating in its students the most productive use of Internet access that can help them to achieve life goals and bring about life changes (dos Santos et al., 2020). Naturally, teachers alone are not being held responsible for these educational failures, as they only occupy one end of the educational system. On the contrary, with no awareness on the part of Brazilian policymakers to focus efforts and resources on effectively addressing the most harmful digital divide, the problems above tend to continue and worsen.

Education 4.0 emerged as a response to the idea of Industry 4.0, a proposal launched at the 2011 Hannover Fair in Germany, an annual event that brings together all that is most modern in terms of technologies for industry. It was born out of a need for the world to develop to meet the demands that will undoubtedly arise with the way society has been evolving towards the so-called Innovation Society (Puncreobutr, 2016).

Therefore, the objective of this work was to elaborate a model of the Education 4.0 teacher, integrating Siemens’ Connectivist Theory (Siemens,

2005, 2006b) with Papert's Constructionism (Ackermann, 2001; Papert & Harel Caperton, 1991). Connectivism brings principles that can accommodate the current context due to the demands arising from the transformations we have noticed and assists learning and knowledge through the conception of connections. At the same time, Constructionism highlights ideas such as learning by doing, emphasising the importance of this process for learning.

## THEORETICAL REFERENCE

Here, we will briefly present the theoretical framework of Siemens' Connectivist Theory and Papert's Constructionism, as well as Education 4.0, in our constantly changing society.

### The Changing Society: The Revolutions

Our society has undergone numerous transformations, changing how we live, communicate, work, and learn. Such transformations are sometimes so profound that they are called *revolutions*, as in 'Industrial Revolution'. Schwab (2016, p. 11) states that the word 'revolution' indicates a profound and sudden change in something and that the associated changes have usually had some relationship with the emergence of new technologies that transformed the social context as a whole, involving sectors such as economy, society and culture. However, technologies should not be held responsible for perceived changes; instead, in a dialectical process, technology adapts to society's demands while influencing it, providing a better quality of life, comfort and practicality (Castells, 2005).

Historically, there have been at least three major and significant Industrial Revolutions.

The First Industrial Revolution, started in England in the 17th/18th centuries, was characterised by mechanical production that took place through the "construction of railways and the invention of the steam engine" (Schwab, 2015) with a predominance of the development of the agricultural, textile and industrial sectors and steel.

The Second Industrial Revolution spread to other European countries and was marked by 'Fordism', which became known as the period that gave rise to mass production, optimised by the technical and scientific innovations

available at the time, through the advent of electricity and assembly line (Schwab, 2015).

The Third Industrial Revolution is also called Industry 3.0 or Digital and Information Revolution due to advances in electronics and information technology in fields such as robotics, computing and telecommunications (Schwab, 2015).

At this moment, we would be entering a Fourth Industrial Revolution (Bloem et al., 2014; Buhr, 2017; Schwab, 2015) based on an expansion and fusion of digital technologies that connect intelligent systems and processes in the industry anchored in the use of the Internet, with speed, exponentially unprecedented scope and impact. More than simply an extension of the Third Industrial Revolution, the interconnectivity promoted by this Fourth, through mobile devices, the Internet of Things, autonomous vehicles and Artificial Intelligence, among other aspects, will undoubtedly change societies in all countries almost simultaneously.

However, this Fourth Industrial Revolution differs from its predecessors in the speed with which innovations emerge and the ability to integrate different technologies. As a simple example, one can cite smartphones that today bring together what were once several other devices, such as a calculator, schedule, alarm clock, flashlight, notepad, digital camera, TV, video game, digital book, scanner., map, etc., into a single one

For Deguchi, Hirai, Matsuoka, Nakano, Oshima, Tai and Tani (2020), Big Data analysis, Artificial Intelligence and the Internet of Things are just a few of the technologies that permeate our current lives. Even if we do not realise that we are under their effects and unconsciously produce the data that feeds these technologies. These, among many other disruptive technologies, completely break with what was known and used by everyone. That is why it did not take a fleet of cars, an in-house restaurant or a hotel chain for apps to become some of the most profitable start-ups.

Araújo, Castro, Maia, Granja and Jovarini (2020) state that the work organisation has been changing significantly in time and space as work processes are increasingly “digitised, decentralised and less hierarchical”, demanding greater flexibility in terms of work processes, people and organisations.

Toffler, in his classic work *The Shock of the Future* (1970), analysed social and technological changes in a broader perspective because of the intense process of continuous technological acceleration that affects us in everyday

situations, even transforming the way we relate, act, communicate, hire services and make purchases. According to Toffler, this acceleration “is not limited to affecting industries or nations, but deeply infiltrates the personal lives” of individuals, provoking in them a new and inevitable psychological illness called ‘future shock’ (Toffler, 1970). According to Toffler, many would react against any ‘mutational acceleration’ (Toffler, 1970), always hoping that everything would return to the way it was in the “good old days”.

In this way, if different segments of society undergo drastic reformulations, it is desirable that the educational model does not refuse change and remains stagnant. Among its many attributions, the school has the role of training individuals who can act as critical and active citizens in different contexts. However, to make this possible in the current conjuncture, it is necessary to look at numerous variables that involve their training, from the current educational system to the teacher who will be involved in the process of training these subjects (Castells, 2005).

As a result, Bregman (2014) argues that, instead of adapting to changes to meet the labour market, perhaps it is the labour market that is adapting to people’s new lifestyles. Consequently, Bregman (2014) questions whether we are asking “wrong” questions, which drive current concerns and education investigations. Instead of talking about what students **need** to know for the future, we should ask ourselves what knowledge and skills **we want** today’s students to have in 2030. Instead of anticipating and adapting, we would focus on guiding and creating (Bregman, 2014, p. 74, emphasis on the original).

Bregman (2014) states that it will not be the market or technology that will define what has real value, but society, and that if education is restructured to meet our new ideals, the job market will adapt them with ease. Instead of education having to be modified to meet these changes in the world of work, it needs to change because our lives are no longer the same as they were a few decades ago; long before work activities, it needs to prepare us for life (Bregman, 2014).

Thus, Education 4.0 would meet the needs of professionals to prepare and adapt to this new job market and the so-called Society of the 21st Century (Fisk, 2017), which needs citizens to act and participate in it in a different, dignified manner, with a sense of responsibility for themselves and their fellow men.

Education 4.0 is a concept developed from the term Industry 4.0, coined by Klaus Schwab in 2015 (Schwab, 2015). The idea of Industry 4.0 was

launched in 2011 during the annual Hannover Fair in Germany, an event that takes place in the city that gives it its name and brings together all the most modern technologies for industry. It was a particular moment experienced by that country, which sought to integrate Higher Education Institutions, companies and government through cutting-edge technology. This Industry 4.0 proposal was implemented in 2013 to modernise local industries, representing a German government strategy that combined technology and means of production. (Schwab, 2015).

What is believed to be necessary for Education 4.0 is the scope of innovation through knowledge, based on the premise that knowing how to go in search of information is not enough. It is necessary to be critical when looking at technologies and understand that it is possible to trace paths so that this information is helpful in some way, which will lead to producing knowledge.

For digital skills and, above all, knowledge and skills that are primarily relevant to students to develop, it is first necessary for teachers to be subsidised so that they can be at the forefront of this process (DE dos S. Silva et al., 2019; DE Silva et al., 2021). However, naturally, teachers cannot be reduced to just a few competencies or skills, as they will not be solely responsible for the failure or possible success of students.

Therefore, the importance of the present teacher as a mediator is crucial, and this is just one of the characteristics that we believe compose the profile of Education 4.0 teachers. It is necessary to recognise that the skills that could be built with their students should emanate from the teacher (Bagdadi et al., 2020).

Teachers must understand their professional role and need to seek, autonomously and adapted to their reality, ways to make the teaching and learning processes more effective and have different resources that can help in their practice. It should be noted, however, that if the teacher is responsible for acting in this search process, it is not only from him that the skills will come: encouragement is needed.

### **Constructionism**

Constructionism, by Seymour Papert, is based on Piaget's idea of the construction of knowledge structures, which happens mainly in contexts in which students are consciously involved in elaborating something. It also

affirms that it is possible to learn with minimal teaching, supported by different motivations (Ackermann, 2001; Papert & Harel Caperton, 1991).

It would now be up to the teacher to adopt a more focused stance on leading to the necessary sources for constructing students' knowledge while they assume a leading role in their learning (Papert, 1993).

Papert's proposal does not aim to deal with computers in education. The author argues that computers have a prominent role because they deal with a comprehensive view of learning in education. That is the Constructionist perspective (Papert & Harel Caperton, 1991, p. 11).

Therefore, Constructionism focuses more on the art of learning, and the importance of getting things done in this process, being interested in how students engage with the activity and how interacting with others can enhance self-learning, thus facilitating learning, the construction of new knowledge (Ackermann, 2001).

The constructions of physical artefacts support mental structures; for this reason, there is not only one possible construction for learning. All paths are also valid, and the questions and concerns produced are fundamental (Papert, 1993).

For Papert, it is vital to consider the existence of tools as means of communication and the context in human development. From there, individuals will give meaning to the life experiences that constitute them, favouring the creation of conditions conducive to learning so that, from then on, they interact with the world (Papert, 1993).

However, Papert's proposal does not question or suggest that instruction should be abandoned in any situation, even because it considers this attitude unproductive (Papert, 1993). However, it is assumed that individuals benefit and develop better if the search for knowledge starts from their interests. This will promote discoveries leading to learning, thus supporting their needs more precisely, without anyone telling them what is important or desirable to study, know, and explore (Papert, 1993).

Thus, Papert introduced the concept of Mathetics, which would be to learning what heuristics are to problem-solving. For Papert (1980), two mathetic principles would be ideas that illuminate and facilitate the learning process:



First, relate the novelty to be learned to something you already know. Second, take the new thing and make it your own: make something new with it, play with it, and build with it. For example, to learn a new word, we first look for a familiar “root” and then practice using the word in a sentence of our own construction (Papert, 1980, p. 148).

Another important aspect is the appreciation of the teachers’ learning since it will be effective when the individual is involved with what they produce. It is essential to qualify or train teachers through the concept of learning by doing, which highlights the need for these moments not to be merely lectures, but spaces that promote the construction of artefacts that support their practice as teachers (Papert, 1993).). However, teachers will not necessarily explore something of personal interest, as training must enable them to innovate, recognise and consider the needs of their students (Papert, 1980).

### **Connectivism**

In turn, Connectivism is a theoretical proposal by Siemens (Siemens, 2005, 2006b) designed explicitly for the current moment, considering that it is necessary to think that the transformations that society has undergone in recent years directly influence our way of learning. According to this author, “the underlying conditions have changed significantly,” so learning can occur from the external environment beyond the individual’s control.

Siemens (2005) points out that the development of information in earlier times was slow; therefore, students from a few decades ago would complete the schooling phase and probably start careers that would accompany them for a long time. According to this author, society undergoes constant changes, and the useful life of knowledge is measured in months or a few years. This brings the need to think about how learning and knowledge take place in a context so influenced by digital technologies and of a theory of learning that highlights this ephemerality of the digital age.

According to Siemens (2005), Connectivism is understood on the premise that society is changing rapidly, new information is acquired continuously, and, thus, it would be imperative to develop the ability to distinguish relevant information from what is not.

As a result, for Siemens (2005), formal education would no longer comprise the totality of our learning, as knowledge can occur in different ways,

through connections between individuals and different environments, since it inhabits the world, and learning would consist of into a continuous and lasting experience.

Siemens (2006b) considers that the context influences the ability to transmit thought regarding the concepts of knowledge and learning; therefore, we connect more than we build. Time and space would no longer impose limits, as we would now connect, create and share knowledge and not just consume it (Siemens, 2006b).

Siemens (2005) states that theories such as Behaviourism, Cognitivism and Constructivism were created in times that were not yet permeated by the technologies we know today and know that they can be used as potential tools for knowledge.

Therefore, the principles of George Siemens on which we are based, as we consider them central to the constitution of what leads us to a profile of the education 4.0 teacher, are (Siemens, 2006b):

- Learning and knowledge are based on the diversity of opinions,
- Learning is a process of networking,
- Knowledge may reside in non-human environments,
- Learning is a constant,
- Creating connections involves skills from the current world and
- Decision-making is necessary for learning.

Regarding the first principle highlighted by Siemens (2005), we can underline that, for knowledge to be free, it is necessary to respect the different ways in which it is interpreted. Therefore, being a teacher now requires discernment and preparation to understand that knowledge, today, is no longer seen as something that can be transmitted. It is now understood that knowledge can and should be built, connected, and that depends on each individual and his or her form of personal understanding, as well as the context in which it was constituted (Siemens, 2005, 2006b).

Concerning the fact that it is necessary to overcome what is already known at all times, there is, in fact, a constant renewal of available knowledge that is now accessed much more quickly compared to previous times. Ordinary individuals consume information, produce, and share it with other subjects, forming networks (Siemens, 2005).

It is pertinent to highlight that at least two theoretical articulations, Andragogy and Heutagogy, can help in the constitution of the 4.0 teacher because they deal with the development of autonomy and responsibility for their own learning, especially when it comes to adults.

Soares, Braúna and Saraiva (2019) discuss Andragogy, a theory introduced by (Knowles et al., 2005) that is dedicated to the investigation of adult learning, especially for the initial and continuing education of teachers. It predicts autonomy, especially in practices based on the perspective of learning by doing, thus successfully linking to Constructionism.

On the other hand, Heutagogy (Hase & Kenyon, 2000) is better articulated with Connectivism because it is centred on the autonomy and self-learning of subjects, as well as on the sharing of knowledge that each participant in the training has.

## **METHODOLOGY**

This theoretical investigation adopts a hermeneutic approach to text analysis (Palmer, 1969). The methodology in the hermeneutic approach consists of interpretation intended as a dialectic back and forth between the meaning of the single parts of a text (oral, written etc.) and its global sense.

The texts analysed here are the aforementioned primary sources of Siemens' Connectivist proposal (Siemens, 2005, 2006b) and Papert's Constructionism (Ackermann, 2001; Papert & Harel Caperton, 1991), aiming to identify characteristics that can lead to the Education 4.0 teacher.

## **RESULTS AND ANALYSIS**

Education 4.0 was analysed, and a profile was outlined to define or guide the character of the 4.0 teacher.

We believe that the integration between Siemens Connectivism and Papertian Constructionism occurs when we consider two aspects brought by both learning and knowledge.

If, on the one hand, Connectivism brings that decisions in technological contexts are based on increasingly rapid changes and that understanding that there are necessary skills now being based on the connection that can be created between subjects, on the other hand, Constructionism values constructions

individuals believing that learning occurs through them, being even more significant when it is “shown to the world”, leading subjects to create their own knowledge networks from the connections (Papert, 1980, 1993; Siemens, 2005, 2006a, 2006b).

Siemens (2005, 2006a, 2006b) points out that, by expressing what is found in the field of thought and ideas, the individual shapes the still confused elements in his power, while, for Papert (1980, 1993), the constructions that occur in the external environment support what happens in the minds of individuals.

The process of building something and being able to share it with the world proves to be significant because by exposing the deed, the subject puts himself in a position to receive new ideas and suggestions, engender relationships and re-signify production based on what his peers have built. This collaboration between subjects delivers the connection process that can give rise to different nodes and knowledge networks (Papert, 1980, 1993; Siemens, 2005, 2006a, 2006b).

Papert (1980, 1993) considers it possible for learning to take place with a minimum of teaching so that, when we establish connections and create networks of knowledge with different nodes (Siemens, 2006b), we will be autonomously learning with minimal teaching.

Figure 1 summarises the most emblematic characteristics of Siemens’ Connectivist proposal (Siemens, 2005, 2006b) and Papert’s Constructionism (Ackermann, 2001; Papert & Harel Caperton, 1991), as identified by Lemes (2022).

**Figure 1**

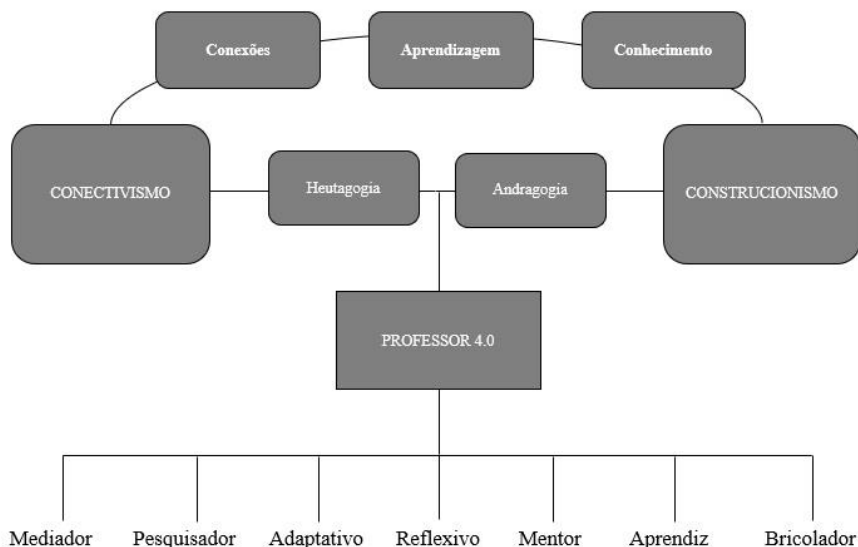
*Comparison between Connectivism and Constructionism. (Rudders, 2022)*

<b>Conectivismo</b>	<b>Construcionismo</b>
<ul style="list-style-type: none"><li>• Integra Caos, Rede, complexidade e teorias de auto-organização.</li><li>• Conhecimento acionável, ou seja, pode residir fora de nós mesmos.</li><li>• Conhecimento está nas redes</li><li>• Aprendizagem a partir da interação com meio externo.</li><li>• Conectar</li><li>• Conhecimento através de conexões entre indivíduos</li><li>• Conhecimento pode formar diferentes 'nós'.</li><li>• Decisões se baseiam em alterações rápidas, pois novas informações estão sendo adquiridas de forma contínua.</li><li>• Habilidade de reconhecer informações com potencial de importância ou sem importância, é fundamental.</li></ul>	<ul style="list-style-type: none"><li>• Parte do Construtivismo de Piaget</li><li>• Aprendizagem pode ocorrer através de construções.</li><li>• Aprendizagem pode ocorrer com o mínimo de ensino.</li><li>• Importância de criar artefatos no processo de aprendizagem.</li><li>• Construir</li><li>• A construção torna-se mais significativa quando pode ser mostrada ao mundo.</li><li>• As construções do meio externo, apoiam o que ocorre na cabeça.</li><li>• Aprender fazendo</li><li>• Busca por conhecimento parte de interesses individuais.</li><li>• Produção, Exploração, Construção.</li></ul>

Thus, exposing the constructions and interacting with the world (other individuals) increase connections with others, producing new knowledge through this exchange. Therefore, the concept pillars that anchor teacher 4.0 are connections, learning and knowledge, starting from both intertwined theories, as seen in Figure 2.

## Figure 2

*Integration between Connectivism and Constructionism to form the profile of Teacher 4.0. (Rudders, 2022)*



Therefore, even though it is difficult to define what Education 4.0 teachers will be like and how society and authorities will see these professionals, we understand that it is necessary to point out which possible aspects would be able to define the 4.0 teacher. We emphasise that the teacher must know that his performance will no longer be based on transmitting knowledge, not even his protagonism, in the classroom, as students will increasingly value their own learning process (Papert, 1980, 1993; Siemens, 2005, 2006a, 2006b).

It is understood that what is expected of teachers is still not completely clear. However, it is already possible to imagine that Education 4.0 teachers should reflect on their practice, modify their professional posture, and understand their role in the face of the dynamic restructuring of society more than believe that it is just about teaching methodologies.

Thus, to rethink the role of the teacher and how he should act in today's society, in a dialogue between Constructionism and Connectivism, seven characteristics are described below that we believe can lead to the profile of the 4.0 teacher.

## **Mediator**

For Libâneo (2011, p. 2), the mediator or facilitator teacher includes those who believe they are more up-to-date, seek to use different methodologies, and make use of various resources that can enable their students to realise they are responsible for their actions and not just reproducers of what is said by the teacher.

In this way, the mediator characteristic consists of a professional who does not take for himself the centrality of knowledge and recognises that students can share knowledge and that these can be a bridge for the construction of new knowledge, counting on the teacher to help and show paths, never to indoctrinate.

However, it is not correct to imagine that being a mediator reduces, in the teacher, his work or the need to act intensely in contributing to the construction of his students. On the contrary, it is plausible to consider that Education 4.0 increases the demand for teachers to be more critical, promoting stimuli and incentives that are more significant to their students and, consequently, they have the need to seek more and more qualifications.

## **Researcher**

Moreira (2008) states that most studies stay away from teachers who know the daily reality of classrooms. As a result, teachers end up not being interested or even participating in these and, even knowing the research results, little or nothing changes in practice.

Even more, Moreira (2008) states that the problem is not in making the research reach the professor but in the researcher's understanding that the professor is not unprepared to conduct it. It is up to the researcher to assume an open stance and be willing to listen to the teacher's demands, thus enabling a fruitful exchange of experiences so that the teacher can also adopt the posture of a researcher.

In this way, research activities must approach teachers who already work in their profession to promote an education involved in exploring, investigating and analysing, reducing transmission and forming questioning individuals who produce innovation from plural knowledge.

## **Adaptive**

Concerning this characteristic, the teacher must be able to adapt to the changes that arise but not accept everything without questioning and reflecting on whether the changes in question are in accordance with their reality and that of their students (Cardoso et al., 2014).

This feature can be essential for teachers since the current moment requires these professionals to reinvent themselves constantly, needing to be prepared for unusual situations that may occur, interacting, thinking, developing and communicating better in their environment.

## **Mentor**

The word mentor refers to “one who dispels darkness”.

Considering that in two decades, students will reach a high level of independence, according to Fisk (2017), they will need, among many other measures, to have a mentor teacher who knows how to guide students in their constructions among the vast availability of information.

## **Apprentice**

It is common to relegate that teachers can and should continue to learn and develop and even show themselves ‘vulnerable’ in terms of not wanting to admit that they do not know everything and leading their teachers to understand that they, too, always need to learn.

Today’s teachers need to understand their role as eternal learners, who need to develop new knowledge all the time, in the reality in which they live (Papert, 1980, 1993; Siemens, 2005, 2006a, 2006b).

It is imperative to consider the teacher’s learning process, regardless of whether they are in initial or continuing education, making them aware that their role is not just to transmit content, as we are taught by the disciplines aimed at preparing teachers to know how to teach but forget or ignore that they must also learn to learn (Papert, 1993).



## **Bricoleur**

According to Papert (1993), “bricolage would be someone’s ability to explore artefacts and adapt them to their needs so that they contribute to the actions that one has to perform in some task”. Bricolage is using available resources, resorting to improvisation, and searching for what is necessary to evolve, improve or achieve what is desired (Papert, 1993).

It is up to a bricoleur to understand that choosing what will have meaning for him is independent of its pragmatic utility. That is, we do not necessarily need to understand that something is useful only when it has a practical effect (Papert, 1980, 1993).

In this way, a bricoleur teacher is understood as one who explores what is around him to explore new methods and strategies without being tied to scripts, not only to improve his classes but also to bring meaning to his teaching praxis.

## **Self-reflective**

Regardless of the society in which they are, a teacher should reflect on their practice and see this situation in a natural way, understanding that this achievement produces benefits to their performance as professional, helping them to see how they place themselves in front of their learning situations, it is possible to establish goals and strategies to outline their learning path, monitor their performance and interpret the results of their efforts, as well as awaken the same in other individuals (Shulman, 2004).

In line with the posture of a self-reflective teacher, self-regulation of learning can be a determining factor in developing a reflective posture in the education professional since self-regulation has a direct relationship with the core of the individual, influencing perceptions about themselves and their attitudes.

After describing the seven characteristics of the Education 4.0 teacher identified in the bibliographic analysis, Table 1 presents a summary for the reader’s convenience.

**Table 1**

*Summary of identified characteristics of Teacher 4.0. (Adapted from (Lemes, 2022)).*

<b>Features</b>	<b>Descriptions</b>
<b>Mediator</b>	It uses various resources to make its students more protagonists in their own learning process.
<b>Researcher</b>	It approaches research activities to promote an investigative rather than a transmitting education, forming questioning individuals.
<b>Adaptive</b>	It adapts and reinvents itself according to changes arising continuously, questioning them according to its reality and that of its students.
<b>Mentor</b>	It is “the one who dispels the darkness” amid the increasing availability of information and guides his increasingly independent students in their constructions.
<b>Apprentice</b>	He is aware that he does not know everything and, therefore, not only knows how to teach but also how to learn.
<b>Bricoleur</b>	He can improvise, seek solutions, and adapt them to his practice with any new methods, strategies and resources available.
<b>Self-reflective</b>	He sees how he faces learning situations and manages to establish goals and strategies to outline his learning path, as well as awaken the same in other individuals.

However, a survey carried out during the Covid-19 pandemic by digital means with 30 teachers from the areas of biology, physics, mathematics, pedagogy and chemistry, between active and non-active, revealed that 53.3% were unaware of the concept of Education 4.0 (Lemes, 2022).

As a result of this research, the first author developed and made available a format of continuing education courses that proved to be positive for developing the pedagogical praxis of Education 4.0 (Lemes, 2022).

## CONCLUSIONS

Many authors still identify Education 4.0 as merely equivalent to Industry 4.0. Considering, however, that the reality of most schools remains below what happens in industries and the job market in general, it is necessary to question the extent to which education can be thought of as meeting the needs of society.

It is emphasised that technologies are not related to Education 4.0 only through electronic resources connected to the Internet. Nor is it believed that they are the means to innovate in education. This interpretation even presents itself as a risk for Education 4.0 since it can merely attribute to it the meaning of digital education, continuing to support a mechanical education embellished with digital resources.

This research was carried out while the world was facing an atypical situation involving a global pandemic, affecting everyone and demanding sudden changes, even in the essential behaviours and attitudes common to our daily lives.

Teachers and students' lives also had to adapt to keep school activities remote. Although it is not possible to predict what marks will be left by this pandemic, one can expect the emergence of new trends in education, especially as the space for teaching and learning had to be transferred from the school to other environments.

Teachers' performance and profession may be re-signified, which would further promote the need to think and question what should be done for teacher training, helping active and non-active teachers to develop practices that are more in line with the society of the 20th century. XXI and Education 4.0.

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## AUTHORS' CONTRIBUTION STATEMENTS

RPdS and ILL conceived the idea presented. RPdS supervised the planning and execution of the research activity. ILL developed the theory, adapted the methodology to this context, created the models, carried out the activities and collected the data. RPdS and ILL analysed the data, discussed the results, and reviewed and approved the final version of the work.

## DATA AVAILABILITY STATEMENT

Data sharing does not apply to this article, as it is a textual analysis of the primary sources mentioned in the text.

## REFERENCES

- Ackermann, E. K. (2001). Piaget's Constructivism, Papert's Constructionism: What's the difference? *Future of Learning Group Publication*, 5(3), 438.
- Antunes, M. D. L., & Seguro de Carvalho, P. (2015, October). Competências digitais: a utilização eficiente dos recursos. *Actas Do 12º Congresso Nacional de Bibliotecários, Arquivistas e Documentalistas – Ligar, Transformar, Criar Valor, Universidade de Évora, 21-23 de Outubro de 2015*. <https://doi.org/10.13140/RG.2.1.4385.0962>
- Araujo, I. C., Castro, M. C. D., Maia, P. L. O., Granja, D. M. de L., & Jovarini, N. V. (2020). Indústria 4.0 e seus impactos para o mercado de trabalho. *Brazilian Journal of Development*, 6(4), 22326–22342. <https://doi.org/10.34117/bjdv6n4-411>
- Bagdadi, I. M., Vieira, L. P. M. da S., & Anaya, V. (2020). Educação 4.0, material didático e a temática indígena: elos articuladores. *Revista Tecnologias Na Educação*, 34, 7.
- Bennett, S., & Maton, K. (2010). Beyond the “digital natives” debate: Towards a more nuanced understanding of students' technology experiences. *Journal of Computer Assisted Learning*, 26(5), 321–331.
- Bloem, J., Doorn, M. van, Duivestein, S., Excoffier, D., Maas, R., & Ommersen, E. van. (2014). The Fourth Industrial Revolution: Things to Tighten the Link Between IT and OT. In *VINT research report*. Sogeti VINT. <https://www.fr.sogeti.com/globalassets/global/downloads/reports/vint-research-3-the-fourth-industrial-revolution>
- Bregman, R. (2014). *Utopia for realists: how we can build the ideal world*.

Little Brown.

- Buhr, D. (2017). *Social Innovation Policy for Industry 4.0*. Friedrich-Ebert-Stiftung. <http://library.fes.de/pdf-files/wiso/11479.pdf>
- Cardoso, L. A. M., Gonçalves, M., & Roldan, R. R. (2014). Narrativas de Um Professor Experiente. *Anais do XVII ENDIPE - Encontro Nacional de Didática E Prática de Ensino, Fortaleza, 11 a 14 de Novembro de 2014*.
- Castells, M. (2005). The Network Society: From Knowledge to Policy. In M. Castells & G. Cardoso (Eds.), *The Network Society: From Knowledge to Policy* (pp. 3–21). Center for Transatlantic Relations, Johns Hopkins University.
- Deguchi, A., Hirai, C., Matsuoka, H., Nakano, T., Oshima, K., Tai, M., & Tani, S. (2020). What Is Society 5.0? In *Society 5.0* (pp. 1–23). Springer. [https://doi.org/10.1007/978-981-15-2989-4\\_1](https://doi.org/10.1007/978-981-15-2989-4_1)
- Desmurget, M. (2020). *La Fábrica de Cretinos Digitales: los peligros de las pantallas para nuestros hijos*. Península.
- dos Santos, R. P., Bülbül, M. Ş., & Lemes, I. L. (2020). Evidence from Google Trends of a Widening Second-level Digital Divide in Brazil. Even Worse with the Covid-19. *Acta Scientiae*, 22(4), 121–154. <https://doi.org/10.17648/acta.scientiae.6006>
- dos Santos, R. P., & Lemes, I. L. (2020). Nativos digitais não: múltiplas imigrações. In C. T. Kaiber & C. L. O. Groenwald (Eds.), *Ensino e Aprendizagem em Ciências e Matemática: Referenciais, práticas e perspectivas* (pp. 70–80). ULBRA - Universidade Luterana do Brasil.
- dos Santos, R. P., Şahin Bülbül, M., & Lemes, I. L. (2019). School Inequalities and Urban Welfare: Going beyond Socioeconomic Status with Data Science. *Acta Scientiae*, 21(6), 2–27. <https://doi.org/10.17648/acta.scientiae.5494>
- Fisk, P. (2017, January 24). *Education 4.0 ... the future of learning will be dramatically different, in school and throughout life*. Gamechangers. <https://www.thegeniusworks.com/2017/01/future-education-young-everyone-taught-together/>
- Gantz, J. F., & Reinsel, D. (2012). *The Digital Universe in 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East* (IDC 1414\_v3). IDC - International Data Corporation.
- Hase, S., & Kenyon, C. (2000). *From Andragogy to Heutagogy*. <https://researchportal.scu.edu.au/esploro/outputs/journalArticle/From-andragogy-to-heutagogy/991012821597602368>
- Knowles, M. S., Holton, E. F., & Swanson, R. A. (2005). *The adult learner: The definitive classic in adult education and human resource development*. Elsevier.

- Lemes, I. L. (2022). *Formação de Professores: Práticas Pensadas para a Educação 4.0 e Sociedade do Século XXI, sob a Luz do Conectivismo e do Construcionismo* [Tese (Doutorado em Ensino de Ciências e Matemática)] Universidade Luterana do Brasil, Canoas, RS, Brasil. <http://www.ppgecim.ulbra.br/teses/index.php/ppgecim/article/view/406>
- Libâneo, J. C. (2011). Didática e Trabalho Docente: A Mediação Didática do Professor nas Aulas. In J. C. Libâneo, M. V. R. Suanno, & S. V. Limonta (Eds.), *Concepções e práticas de ensino num mundo em mudança: diferentes olhares para a Didática* (pp. 85–100). CEPED/Editora PUC Goiás. <https://doi.org/978-85-64604-02>
- Moreira, H., & Caleffe, L. G. (2008). *Metodologia da Pesquisa Para o Professor Pesquisador*.
- Palmer, R. E. (1969). *Hermeneutics: Interpretation theory in Schleiermacher, Dilthey, Heidegger, and Gadamer*. Northwestern University Press.
- Papert, S. A. (1980). *Mindstorms - Children, Computers and Powerful Ideas*. Basic Books.
- Papert, S. A. (1993). *The Children's Machine: Bringing the Computer Revolution to Our Schools*. Basic Books.
- Papert, S. A., & Harel Caperton, I. (1991). Situating Constructionism. In I. Harel & S. A. Papert (Eds.), *Constructionism: research reports and essays, 1985-1990* (pp. 1–14). Ablex Publishing.
- Prensky, M. R. (2001a, October). Digital Natives, Digital Immigrants. *On the Horizon*, 9(5).
- Prensky, M. R. (2001b). Digital Natives, Digital Immigrants: Do They Really Think Differently? *On the Horizon*, 9(6).
- Puncreobutr, V. (2016). Education 4.0: New Challenge of Learning. *St. Theresa Journal of Humanities and Social Sciences*, 2(2), 92–97.
- Schwab, K. M. (2015, December 12). The Fourth Industrial Revolution: What It Means and How to Respond? *Foreign Affairs*.
- Shulman, L. S. (2004). *The Wisdom of Practice: Essays on Teaching, Learning, and Learning to Teach*. Jossey-Bass.
- Siemens, G. (2005). Connectivism: a learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 3–10.
- Siemens, G. (2006a). *Connectivism: learning theory or pastime of the self-amused? Learning Theory or Pastime of the Self-Amused?*
- Siemens, G. (2006b). *Knowing Knowledge*. Lulu.com.
- Silva, D. E., Corrêa Sobrinho, M., & Valentim, N. M. C. (2021). Utilizando o Modelo ADDIE para o Desenvolvimento e Avaliação de um Processo Educacional Inspirado na Educação 4.0. *Anais do XXIX Workshop Sobre*

*Educação Em Computação (WEI 2021)*, 448–457.

<https://doi.org/10.5753/wei.2021.15936>

Silva, D. E. dos S., Sobrinho, M. C., & Valentim, N. (2019). Criação de Jogos Educacionais para apoiar o Ensino da Matemática: um Estudo de Caso no Contexto da Educação 4.0. *Anais do XXV Workshop de Informática Na Escola (WIE 2019)*, 1179–1183

<https://doi.org/10.5753/cbie.wie.2019.1179>

Soares, A. C., Braúna, R. de C. de A., & Saraiva, A. C. L. C. (2019).

Andragogia: contribuições para a aprendizagem do adulto professor.

*Comunicações*, 26(3), 23. [https://doi.org/10.15600/2238-](https://doi.org/10.15600/2238-121X/comunicacoes.v26n3p23-38)

[121X/comunicacoes.v26n3p23-38](https://doi.org/10.15600/2238-121X/comunicacoes.v26n3p23-38)

Toffler, A. (1970). *Future Shock*. Random House.