Complexity Knowledge and Pedagogical Practices*

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Abstract

This study deals with a research conducted with Brazilian and Portuguese teachers through an online course that aimed to design a continuing education approach that integrated basic, undergraduate and graduate education teachers, based on the "Seven Complex Lessons in Education for the Future." To this end, it focused on the "lesson" that deals with error and illusion, from Edgar Morin's perspective. The problem that guided the investigation sought to analyze participants' perceptions about the influence of pedagogical practice, methodology and the proposed learning on a transformation in teaching. The research used a qualitative, action-research approach, and the data was submitted to content analysis using the IBMS Statistics program. Results indicated the occurrence of reflections about the need to consider a thought-reform approach to education, one that overcomes the fragmentation of knowledge. About student engagement in activities proposed by the teacher in class, participants were found to value interdisciplinarity, collaboration, collective work, and the mediation role, and to recognize the influence of psychological aspects on students' interest in and motivation for learning. Finally, the need to overcome determinist thoughts was considered, thus allowing participants to understand that knowledge is subject to errors and illusions also in education, and that expanding human thought can help in the search for solutions to educational problems.

Keywords

Complexity – Seven complex lessons – Pedagogical practice.

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Introduction

This study is part of a network research with Brazilian and Portuguese universities that examined the creation, development and delivery of an online teacher education course. The research aimed to disseminate the discussion around complex thinking, with an emphasis on Morin's (2001) thought, in particular his book *Seven Critical Lessons in Education for the Future*. This reference work presents chapters titled by the author as: (i) detecting error and illusion; (ii) principles of pertinent knowledge; (iii) teaching the human condition; (iv) earth identity; (v) confronting uncertainties; (vi) understanding each other; and ethics for the human genre.

The online course was divided into seven modules, each providing insights and spaces of study, reflection and discussion about one of the chapters of Morin's book. This article summarizes the analyses conducted about the first chapter and examines the perceptions of participant teachers about the influence of the "lessons" proposed by Morin (2001), in particular the one about error and illusion and how it influences pedagogical practice. The investigation sought to: (i) systematize the information provided by participant teachers in the forums; (ii) establish categories, codes and units of analysis, classifying the contributions from participant teachers; and (iii) identify their perceptions about the contributions of the study to the transformation of pedagogical practice. Morin's (2001) studies about complex thinking comprehend the need for school education to find paths for overcoming the transmission of contents, the fragmentation of knowledge and, in this transformation process, they seek to educate for humanization, for responsible citizenship and for the construction of a planetary civilization based on fraternity, mutual commitment and the inclusion of those who are marginalized, among other challenges. It is an education for life, and to this end it is urgent and necessary that a paradigmatic change occurs, a change that requires time for reflection and sharing, as well as the creation of spaces of discussion, knowledge and exchange of experiences.

Based on this view of shared education, the online course above was delivered in order to lay foundations for a possible paradigmatic change to teaching that might overcome the conservative view and embrace the complex thinking proposed by Morin (2001)

The Pertinent Subjects Involved in the Continuing Education Process

While the book proposed for the study is intended for educators and expatiates on the validity of the necessary knowledge to the future of education, Morin (2001) stresses, from the outset, that it is not a guide, i.e., it does not provide recipes or models, but foundations that should pervade and intertwine with the contents taught in school.

The free and voluntary way in which the course was delivered seems to agree with the essence of the concept of knowledge, since by providing content and a space for discussion in the forums, with various possibilities of access, interaction between participants, contact with information and with shared knowledge around reflections,

it emerges as a pathway that can start a paradigmatic change, mobilizing teachers and seeking to arouse interest in the new.

This need for transformation, which is proposed by complex thinking theory, requires understanding the human condition and humans' earthly identity, ideas proposed by Morin (2001). It is thus that knowledge around trandisciplinarity gradually developed. The term emerged around 1960; according to Nicolescu (1999, p. 11), the term gradually arose "[...] in the works of different researches like Jean Piaget, Edgar Morin, Eric Jantsch, and many others." Morin (2001) explains that its invention broke with the limits established by disciplines.

The meaning of the term 'trandisciplinarity' passes through the ideals of pluridisciplinarity and interdisciplinarity, both of which, for Nicolescu (1999), keep the idea of separation, whether because of their methodological specificity or because of the object's belonging to a particular discipline. Over the paths of science, this approach seeks to make the individual aware of the need for them to take on their role in planetary life and understand the consequences of their attitudes and decisions. Interestingly, this new paradigmatic construction carries within it the possibility of a fresh start, of integration and of collectivity; what is more, through scientific evidence and solid arguments, it founds knowledge in education.

In order to find paths in the science of education for overcoming fragmentation and valuing the transdisciplinary aspect of knowledge, Morin (2001) indicates the need to reflect about the knowledge that can influence the education processes experienced by teachers and students. For this reason, this course sought to enable learning with a focus on teacher education, so that the content might be recognized as significant for participants and considered applicable to their pedagogical practices.

According to Morin (2001), the knowledge that includes the possibility of error and illusion, both of which are present in knowledge development processes, has always accompanied the discoveries made by man. Moreover, according to him, not rare were the times when humanity erred or was illuded about its discoveries and convictions, with regard to understanding about man, society and the world around it.

The problem of humanity lies precisely in recognizing the presence of uncertainty, particularly when it comes to developing knowledge, argues Morin (2001) in his studies. For the author, one of the roles of education is to teach that, historically, science, conceptions, ideologies, principles were determined by errors and illusions, and that we are always subject to that. Considering the principle of such knowledge, many questions could be overcome with regard to understanding, being, doing, living together and coexisting, all indispensable learnings, which were proposed in Delors' (1998) report.

Among the aspects that concur for the occurrence of error and illusion, according to Morin (2001), is the fact that intelligence cannot be separated from affectivity and that emotions interfere with our behavior of reasoning. Thinking in this way, Morin (2015b, p. 99) finds it "[...] surprising that education, which aims at communication, is blind with regard to what human knowledge and its devices, weaknesses, difficulties, and propensity to error and illusion are, and is by no means concerned with leading to knowledge of

knowing". Thus, it can be said that, from Morin's (2015b) perspective, the study of teaching these aspects should be part of teacher education.

Likewise, education must necessarily begin its processes by "[...] knowledge of the knowledge that would prepare us for the permanent risks, which do not cease to parasitize the human mind" (MORIN, 015b, p. 100). On this path of acquiring knowledge of knowing, Morin (2001) refers to the possibility of the unexpected and presents a few aspects that influence the construction of knowledge and can interfere with the transmission of information: mental and intellectual errors, errors of reason, and paradigmatic blindness.

In order to understand how knowledge is processed, it is interesting to know how teachers perceive their pedagogical practices, their methodological decisions, their interpretation of the educational context, their professional understanding.

In fact, scholars of education are constantly dedicating time and space in their works to speaking about the value of research for the teacher education process, and they warn that overcoming educational problems, among other aspects, involves sharing information and debating about experiences. These authors, such as Imbernón (2009), Demo (2009), Pimenta (2011), Morin (2015a, 2015b, 2015c), and so many others highlight the need to share teachers' experiences, insights, and perceptions in dealing with commonplace educational situations. For Pimenta (2011):

> Within teaching practices lie extremely important elements, such as problematization, the intentionality towards finding complex teaching solutions, the most radical, richest attempts, the ones that are most suggestive of an innovative didactics, which is not yet theoretically configured. This vast, complex output tends to be lost, diluted, and stay at a commonsense level (PIMENTA, 2011, p. 68).

In order to present teachers' perception of the knowledge that deals with instances of blindness of knowledge, considering the principles of complexity theory, this study describes the methodological path used to reflect about the contributions of participants in the course with regard to their understanding of the content and to its applicability to their pedagogical practices.

The Methodological Path

The qualitative research sought to capture, in the investigation process, how the teachers involved in the online program perceived the "seven critical lessons in education for the future", particularly the first lesson proposed by Morin (2001), i.e., "detecting error and illusion", as well as its influence on the possible paradigmatic change to teaching practices. The activities were coordinated by four researchers, with two of them being Brazilian and two Portuguese; in addition, four PhDs and eight master's and doctoral students who were members of the study group also participated. The online program was open to the community via virtual invitations and involved 51 participant teachers enrolled in the course who teach at different education levels. Of this 51-teacher group, 40 were Brazilian and 3 were Portuguese.

The action-research method was chosen for the qualitative research, since, according to Thiollent (2011), different methods or strategies can be aggregated so as to establish a collective structure for capturing information. Thus, action-research, in which the subjects who investigate are immersed in the environment where the object is observed and analyzed, was chosen. The members of the study group for this research were involved in the stages comprising from the creation and organization of materials, resources and contents to following and participating in the virtual meetings, and they took on differentiated roles in tutoring, structuring, and making the necessary adjustments, as well as helping with the collection of perceptions recorded by the teachers involved.

All of the researchers involved remained integrated in the process, sharing their perceptions in the spaces for online communication, in an asynchronous manner, i.e., not necessarily at the same time, but according to the availability of the enrolled participants. The activities delivered through the network were organized, monitored and developed in a collaborative manner, with the study group teaching and learning through interventions in the investigative process.

The collection of data used a virtual netnography database, considering that participants were able to record their ideas through the web and dialogue with their peers, thus constituting the study's data corpus. Data were treated by means of content analysis, based on Bardin's (2016) studies, using IBM SPSS Statistics for basic statistics, in order to determine the frequency of occurrence of information that was shown to be of greater or smaller relevance in what was mentioned by teachers in the forums.

The pre-analysis included reading the records in the spaces created on the course's online environment, which constituted the first stage of the content analysis proposed Bardin (2016); these spaces were organized as forums, which were denominated as follows: socializing and introduction; case study; starting point; practice in practice; and complex thinking in pedagogical practice. The creation of these spaces aimed at allowing integration and interaction between participants and mediators. The records of their contributions were considered as the universe of documents collected for analysis (BARDIN, 2016).

Free-floating reading allowed identifying information in the forums, where the contribution provided by participant teachers were gathered, during the communication taking place around the questions that were proposed to instigate reflection about the knowledge, experiences, and influences of a possible beginning of paradigmatic change in teaching.

The decision to work in this way was based on Bardin (2016), as it was found to be a coherent procedure for capturing, from teachers' recorded perceptions, the characteristics that define attitudes, values and other aspects of a behavioral or cognitive nature. As for the use of the IBM SPSS Statistics program, it helped to reach greater rigor and accuracy in counting and determining the percentages of frequency and occurrence of information contained in responses, and thus the qualitative analysis considered the dimension of attention dedicated by teachers to the aspects proposed by means of reflective questions.

Responses were examined considering the reflections recorded by participant teachers about their own practice in light of theory, according to the analysis of their responses. Their contributions showed that, of the 51 teachers enrolled in the course,

36 spoke about five different types of expectations for their participation in the course, which were denominated as follows: learning of proposed contents; application of the acquired knowledge to the career; sharing of knowledge and experiences; the possibility of learning innovative approaches; and reflections about improving pedagogical practices so these can help with student learning.

The contributions provided in the forums were distributed over an electronic spreadsheet (Excel), initially by entering teachers' codes[3] according to the expectation type they mentioned. Finally, data were launched in the IBM SPSS Statistics program, which organizes information automatically in a table format (Table 1). The first line indicates the five expectation types, the second line indicates the valid number (N) of teachers who mentioned the type of information indicated in each column, and the third line shows the number of teachers who did not mention any of these types, i.e., who did not manifest themselves about this aspect.

Table 1 - Expectations for participation in the course

		Learning	Career	Sharing	Innovative approaches	Pedagogical practice
N	Valid	31	2	14	7	13
	Absent	20	49	37	44	38

Source: data from the research.

Table 1 shows that mentions of the expectations above by teachers did occur, indicating also how frequently they were mentioned in the group, based on data submitted to IBM SPSS V22. Thus, 31 of them (i.e., 60.8%) indicated "learning about the proposed content" as an expectation for their participation in the course, 2 (3.9%) thought about "improving knowledge around the teaching career", 14 (27.5%) enrolled in order to "benefit from the opportunity to share knowledge", 7 (13.7%) wanted to "learn an innovative approach", and 13 (25.5%) wanted to "reflect about teaching practices". Of the 51 enrolled participants, 15 did not manifest themselves. Among the expectations regarding the course, teacher PT10 mentioned "improving knowledge", and PT15 said, "I believe continuing education is a chance to reflect about our practice. My goal for this course is to seek theoretical foundations for this reflection and action in the school".

Among teachers' expectations, there emerged the perception that the course could provide them with learning about teaching, whether regarding contents, pedagogical practices, and/or the possibility of sharing experiences and knowledge. During the program, through teachers' access to the contents and through their participation in the

3- Teachers' contributions were coded using the initial letters PT (participant teacher) followed by sequential numerals from 1 to 51.

proposed discussions, participants offered some contributions as to their perceptions on how to apply the acquired knowledge to their own pedagogical practice.

Understanding of the Content Applied to Pedagogical Practice

The record units are represented by words, sentences or passages, which are selected for analysis. For Bardin (2016), these mean "what" and "how" to count in terms of determining the occurrence and frequency of the investigation data – in other words, it is necessary to define the count rule. Therefore, the "pedagogical practice", "teaching methodology", and "factors" categories were established based on terms used in the statement designed to propose the three reflective questions in Module 1 about Morin's (2001) first lesson, "detecting error and illusion". The questions were: 1) How can the text help teachers reflect on and transform their pedagogical practice? 2) How can the methodology used by the teacher influence students' interest and engagement in the proposed activities, and what actions can the teacher take to strengthen engagement during class? 3) What factors involve pedagogical practice and can be worked on so teachers can develop class activities that ensure students' active and interested participation?

The subcategories were created by reading participant teachers' contributions about their conceptions regarding the aspects investigated in the reflective questions. The whole contribution or sentence written by the teacher was divided and considered as a unit of analysis. Thus, where the sentence expressed a theoretical meaning, it was associated with the pedagogical practices category and coded with letter 'A'; where it indicated a perception about technical aspects of teaching, it was grouped in the methodological category (letter 'B'); and where it dealt with a human question, it was associated with the factors category (letter 'C'), which, in teachers' perception, could influence student involvement and engagement in class. This is a considerate procedure, from Bardin's (2016) perspective, and the decision to use this form of analysis was made considering that the statement referred to specific points in teaching, and the invited contributions should use as a basis information founded on the proposed content.

The category denominated as pedagogical practices was represented by letter 'A' in Chart 1 and created by gathering information consistent with the *Thesaurus brasileiro da educação* [Brazilian Thesaurus of Education]:

> [...] development of the pedagogical approach defined by and known to the whole school community, the pedagogical didactic plan, the contextualization of educational action, the range of teaching-learning strategies and resources, the encouragement of autonomy and collective work [...] (BRASIL, 2019, p. 1).

Chart 1 – Data analysis categories

(A) Pedagogical practices	(B) Teaching methodology	(C) Factors
A1 Theoretical perspective A2 Political perspective A3 Social responsibility teacher's role professional responsibility (ethics); valuing of teaching A4 Level and modality A5 Pedagogical approach and policy A6 Planning contextualization A7 Autonomy, cooperation and collectivity	B1 Systematization B2 Rationalization and goals B3 Methods B4 Techniques B5 Resources B6 Attitude B7 Technologies	C1 Psychological

Source: data from the research.

Thus, this category focused on prioritizing mentions of collective work, common to all teachers in the institution. In Chart 1, the terms extracted from the units of analysis form the subcategories that were numbered from one to seven, next to the term indicating the meaning of the information, and were denominated as follows: A1 – theoretical perspective; A2 – political perspective; A3 – social responsibility, the teacher's role, professional and ethical responsibility, and valuing of teaching; A4 – education level and modality; A5 – pedagogical approach and policy; A6 – planning and contextualization; and A7 – autonomy, cooperation and collectivity.

The *teaching methodology category* represented by letter 'B' in Chart 1 refers to the processes established by teachers in order to help with student learning, not necessarily as an institutional policy, as these can even comprise an individual teacher's initiative and are thus related with the teaching action, considering Duarte's (1986, p. 119) definition:

> Systematization and rationalization of teaching through the methods and techniques used by the teacher to intervene in the student's behavior, guiding their learning. This starts from theory of teaching that studies the most efficient resources to steer learning so that certain goals are achieved.

The column that lists teaching methodologies presents the units of response that were then associated to numbers one to seven, denominated as follows: B1 – systematization; B2 – rationalization and goals; B3 – methods; B4 – techniques; B5 – resources; B6 – attitude; and B7 – technologies.

As for the factors category, the associations established in the analysis of data involve the contributions of teachers who approach questions directly related to student development, i.e., questions regarding learning. To reach this insight, the first step was to establish the meaning of 'factor' as an element that concurs or helps to achieve a particular result. Subsequently, the term factors was associated with learning resulting from biopsychic (i.e., physical, psychological, or biological) and sociocultural aspects

which, according to Duarte (1986, p. 14), "[...] reflect on student learning and are linked to determinants that can be hereditary (genetic component) or resulting from nutrition issues". Sociocultural factors deal with the relationship between people and their environment.

Based on teachers' perceptions, the factors category was created and is represented in Chart 1 by letter 'C', with only one subcategory, which refers to psychological aspects and their relations: family, environment, culture, friends, community, and social class, which, in teachers' perception, could influence student learning.

The terms extracted from the reflective questions, which represent the categories, establish relationships between concepts that constitute the field of knowledge of education. They are therefore interconnected, differentiating from one another by a very thin line. For this reason, considering that the questions are open-ended, the creation of labels and codes, according to Bardin (2016), can avoid doubts during the classification process and help to determine the frequency and occurrence of responses.

In order to build their answers, teachers sometimes complemented their ideas by quoting directly the text provided or other authors, with loose words, just agreeing or disagreeing with their colleagues, or expressing personal considerations, as in the excerpt below:

> What we see in many education places where students are *forced* to acquire knowledge imposed on them, they cannot experience it in other ways that might be more pleasant and therefore more receptive on the part of students in massive terms (PP26, emphasis added).

Passages with these characteristics of information were coded in order to allow identification, but were not considered valid in terms of response, as they do not apply to what was approached in the reflective question, a necessary condition for data selection.

The codes assigned to teachers, categories/subcategories and units of analysis were organized in an electronic spreadsheet (Excel) and transported to the IBM SPSS Statistics program in order to determine the occurrence of the information in participants' discourses and the frequency of its meaning as mentioned by the group.

The data was organized automatically by the IBM SPSS Statistics program and is represented in Table 2. The first line establishes the information related to each column. The first column refers to the codes created for the broad categories: pedagogical practices (A); teaching methodologies (B); and factors (C). The second column (N) indicates the number of units of analysis that were created from the records of teachers' contributions in the forum. The third column turns the amount of information into response percentages (%). The forth and last column indicates the percentage of valid responses. This means that not all units of teacher response were considered valid as in contributing by suggesting information to indicate the influence of pedagogical practices, methodologies, and factors that can influence student learning, and as in contributing, based on course readings, possible ideas to transform their practice, which was the point of the reflective questions during forum sessions.

Table 2 - Response frequency by category

Code	N	%	valid %
(A)	257	67.3	80.8
(B)	57	14.9	17.9
(C)	4	1.0	1.3
Total	318	83.2	100.0
No response	64	16.8	
Total	382	100.0	

Source: data from the research.

The second line in Table 2, with information about the pedagogical practices category (A), shows that 257 contributions were gathered, i.e., 67.3% of all that was written by teachers fit in this category, and this was also the greatest response percentage. These units deal basically with theoretical understanding of teaching. In the third line, about methodologies (B), 57 mentions were listed which addressed practical approach examples, with a focus on teaching methodologies; this value represents 14.9%. In the fourth line (C), four inferences were made about factors that influence student learning, which means 1% for 'C' items.

The fifth line in Table 2 refers to a total of 318 units of analysis, 83.2% considered as valid responses, as they were assigned the codes of the categories and respective subcategories. This means that, of 100% of contributions, 80.8% were sentences or ideas considered valid for analysis.

The sixth line in Table 2, labeled by the program as 'No response', indicates 64 units that were not coded, as they were not considered valid. They were shown to be records of direct quotes of Morin's (2001) text, personal opinions or considerations unrelated with the issues approached in the forum's reflective questions. They total 16.8% of the recorded information.

The seventh line in Table 2 indicates a total of 382 units of response, comprising valid and non-valid units of analyses (complete sentences).

This organization, which allows associating teachers' participation also in quantitative values, helps to shed some light on teachers' focus of attention at the time of their responses. This does not mean that they are not concerned with the other categories, but rather that, at that particular time of participation, the debate that appeared most appropriate to them was around theoretical questions, i.e., about the items mentioned in the pedagogical practices category.

Table 3 indicates the occurrence of units of analysis and how frequently they were associated with the categories and respective subcategories, according to the treatment of data through the IBM SPSS Statistics program. The first column indicates the codes of categories and their subcategories as presented earlier. The second column (N) indicates the number of valid units expressed by participant teachers. The third column represents the percentage values (%). The fourth and last column shows the percentage of valid responses.

Table 3 - Occurrence and frequency of responses in the categories and subcategories

Code	N	%	valid %
(A1)	97	25.4	30.5
(A2)	3	0.8	0.9
(A3)	56	14.7	17.6
(A4)	5	1.3	1.6
(A5)	2	0.5	0.6
(A6)	48	12.6	15.1
(A7)	46	12.0	14.5
(B1)	6	1.6	1.9
(B2)	2	0.5	0.6
(B3)	10	2.6	3.1
(B4)	3	0.8	0.9
(B5)	3	0.8	0.9
(B6)	30	7.9	9.4
(B7)	3	0.8	0.9
(C1)	4	1.0	1.3
Total	318	83.2	100.0
No response	64	16.8	
Total	382	100.0	

Source: data from the research.

Category A gathered items approached in the question that sought to investigate how the content provided through the course's materials could help teachers reflect and transform their own pedagogical practices. In this category, item A1 was mentioned 97 times, which represents 25.4%, i.e., the highest rate in all comments made. Responses were similar to those by PT02, in that "[...] the main insight for me, from reading the book, was the reflection that nothing is determined, but rather knowledge is built collectively by means of a dialogical, interested, and participatory practice". Contributions showed that teachers agreed with Morin (2001) when the author says that all knowledge can and should be revised and revisited, just like dialoguing must be open to this end.

Item A2, about the political perspective, was mentioned by a single teacher (PP02), which represented 0.8%, presenting the following inquiries, "How can we politicize our students for a fairer democracy? What kind of a citizen am I helping to educate?".

Item A3, with 14.7%, gathered teachers' perspectives on teacher professionalization, with some mentions being made about social and professional responsibility, the teacher's role, and teacher valuing, as pointed out in Chart 2 below:

Chart 2 - Aspects approached in subcategory A3 about teacher professionalization

Aspect approached	Participant	Contribution
Social responsibility	PT26	[...] Presenting these solutions of the modern, technological world for how they [students] can change, since we "preach" that students are the "future" of the country, I wonder if we are teaching them to build a desirable, better, sustainable future (emphasis added).
Teacher's role	PT08	One factor that I believe would help students participate in activities is leading them to believe in their own ability to learn.
Professional responsibility (ethics)	PT20	Reflecting on the way we are teaching, and why so many students feel demotivated is the first step towards change.
Teacher valuing	PT13	This profession needs recognition. Unfortunately, we are not in a time we can feel proud, because the standards are broken, most teachers are working in more than three schools, four, five, or even seven schools.

Source: data from the research.

Item 4A comprises 1.3% of mentions about education level, with PT21 showing some concern: "[...] since the current generation of children is extremely quick on thinking and doing [...]", and about modality, with PT19 saying that "[...] by using always the same practices, the teacher feels safe, but will not analyze their classroom's reality. They have the illusion that they will succeed".

Item A5 groups 0.5% of discourses about pedagogical approach and policy, as seen in the contributions by PT13: "[...] they need to feel autonomous to propose projects and innovative actions that meet their didactic and learning needs for their students", and by PT32, who absorbed and consolidated the course's main idea, in saying that "[...] after studying this first chapter, some considerations made me reflect about my own pedagogical practice".

Item A6, with 12.6%, gathers responses about planning. For PT02, it is important "[...] to plan and design a class based on the student", and for PT15 "[...] it is important to make the student feel involved in these practices". As for contextualization, PT30 says that "[...] therefore, pedagogical practice should be always changing according to new methodologies and approaches with varied activities, through students' experiences in their environment and the worldviews in which they are socially situated".

Item A7 indicated 12% of approaches about autonomy, cooperation, and collectivity, as exemplified in this contribution by PT13: "[...] the teacher needs a pedagogical team to help them build their curriculum, considering the school's pedagogical guidelines". And also in the views expressed by PP19, for whom "[...] teacher and student can share the same experience and enrich the teaching and learning process", and by PT32, who believes that "[...] the student must be considered in their multidimensionality, and then the teaching-learning process can start, with teachers and students building knowledge together".

The analysis of the participants' perceptions that fit in the categories indicates that all items combine in a whole where they complement one another, in line with complex thinking theory. Thus, the pedagogical practice category grouped perceptions that mention the planning of general educational approaches, which should be known to the whole

school community, considering collective work and understanding. These indicate that teachers understood that the theory proposes a reform of thought, considered necessary by Morin (2001), who shows in his studies that he does not believe that the school of the 21st century provides a suitable education for the social reality that arises.

In one last analysis regarding the contributions by the 51 participants about Morin's (2001) purpose for his book's first chapter, which deals with detecting error and illusion, it should be noted that 27 of them expressed different perceptions on their contact with the content, while the other 24 made no direct mention of the topic, providing further contributions similar to those reported earlier in this article. Thus, the most frequently mentioned content concerned error: nine participants related it to student learning as in information that can help to improve learning quality; five of them thought about the need for teachers to reflect about their own errors in class context; five others referred to behavioral error made in generic terms in human relationships; seven participants spoke about their knowledge of being under threat of error and illusion, as suggested by the chapter's very title; and two teachers associated the studied content and the concept in question with overcoming traditional conceptions of knowledge about pedagogical practices. In Morin's (2001) texts, apparently, the reflections comprehend scientific and philosophical knowledge systematized and configured in the various theories developed over the history of humanity. However, teachers showed that they made an association between their understanding of the text and their reconsidering their actions, even though not referring to questions of a scientific or philosophical nature.

In the chapter of the book which is addressed in this module of the course, Morin (2001) considers that education is responsible for communicating knowledge, which is incorporated in human life through the tools available in each historical period. For this reason it should always be revised and revisited upon each discovery. The author understands that keeping this openness to the new is a lucid attitude, and he suggests that education needs to learn about "[...] brain, mental, cultural characteristics of human knowledge, of its processes and modalities, of the dispositions, both psychical and cultural, that lead it to incur the risk of error and illusion" (MORIN, 2015b, p. 1000). Such learning requires strategies, and that leads to identifying teachers' perceptions regarding the aspect of teaching methodologies.

The teaching methodologies category (B) had its answers grouped in seven items, with B1 obtaining 1.6% of mentions related with systematization, with insights like the one expressed by PT05: "I think it is always fruitful to start from what students know towards what they still do not know" (emphasis added). In Item B2, there was 0.5% of mentions about rationalization and goals, with statements like this one by PT42: "[...] To recognize that in pedagogical practice and in content selection, the teacher should see themselves as a mediator of knowledge, and also that they will consider the limitations and contingencies of knowledge". In item B3, 2.6% of answers spoke about methods, with PT06 and PT12 suggesting, respectively, the need to: "[...] use a methodology that involves the student, that does not consider them as a *blank slate*, allowing students to develop their rationality" (emphasis added) and "[...] include their students in the process of teaching and learning, there should be an exchange of experiences and knowledge, and

use problematization, research, case studies, also between peers". In item B4, with 0.8% of answers about techniques, PT47 indicates that "based on this discussion, the teacher could propose a theme and have students themselves research what is already *known* about the subject; propose a debate so groups can make inquiries, and thus show them that knowledge is not immutable; that errors are also part of discovering" (emphasis added).

Still in the category about teaching methodologies B5, with 0.8% of mentions about resources, PT40 says: "The importance of fantasy and imagination in the human being is unimaginable, so I believe we would have to work on students' imagination so we can use the playful and the real in a different, innovative way". Item B6, with 7.9% of responses, has the highest rate in the category and deals with questions related with teacher attitude; two examples are the contributions by PT02: "The way we work with students can influence, and a lot, the teaching and learning process", and by PT26: "As a teacher, I believe in the good relationship I must establish with my students, arousing affection and bringing them closer to the real world, with its problems, conveniences and difficulties". In the last item, B7, with 0.8% of mentions about technologies, teachers believe in "Exploring the use of technologies in the classroom, with special attention to the cell phone, exploring pedagogical tools often unknown to students in school activities" (PT09), and that "One example is to use technology to benefit learning in the classroom, thus making this student-teacher interaction easier and learning more pleasant" (PT24).

The analysis of teachers' perceptions in this category revealed mentions of: (i) interdisciplinary activities; (ii) the use of new techniques; (iii) the search for student interest, participation, and involvement; (iv) the teacher's role as a mediator; (v) acts of collaboration and cooperation between students and between them and the teacher; (vi) collective work, by considering, in methodological terms, circumstances that are part of the social context the student lives in; (vii) the inclusion of technologies as a pedagogical resource; (viii) valuing dialogue, among other suggestions made, when the forum was described.

For Morin (2015b), the reform of thought involves transdisciplinarity, overcoming knowledge fragmentation, understanding ecology, earth sciences and cosmology, and in addition, for the author, we are planetary beings and will need to develop this civilizing consciousness. It is necessary to learn about solidarity and responsibility through lived experience, and the way forward is to know how knowledge takes place.

The third question investigated the factors (C) which involve pedagogical practice and can be worked on so the teacher can develop class activities with students' active, interested participation.

This third category (C) investigated the factors mentioned by teachers, with mentions of it representing 1% of the total, of the 318 units of analysis considered valid. The only subcategory created was C1, which refers to psychological factors, as can be seen in the contributions by PT02: "Based on the studied text, it is important for us to pay close attention to students' interests and knowledge", by PT06 "[...] students, though sometimes unconsciously, can see the inconsistency and grow demotivated", by PT20 "We know how hard it is win these days; the content imposed by the educational system, the lack of family structure, precarious schools without the minimum infrastructure for proper teaching, students with no motivation whatsoever [...] And thus the domino effect,

demotivated students not even slightly willing to be in a classroom". And PT49: "Children and young people in school think in a radically different way from that of the teacher, and the challenge lies in the dialogue and the relationship between both ways of thinking". Teachers' positions in this forum initially transmitted concerns about students' interest in and motivation to learn and about the student-teacher relationship

In view of the question about factors, also in this forum, the researchers initially expected that teachers would naturally mention biological, psychical and sociocultural influences, and would suggest approaches for transforming practices related to student learning conditions. However, this was the category that received the lowest rate of attention. Much was said in theoretical discussions about the type of understanding of the necessary conception for pedagogical practices, methodological alternatives were suggested, but 1% was the rate found for mentions of the psychological dimension, and nothing was said about biological, physical, sociocultural aspects or about relations with family, environment, culture, friends, community and social class. Perhaps not coincidentally, the theory indicates the need for a reform of thought, which will have to transcend theoretical aspects to express itself in teachers' teaching practice, with cognitive strategies that lead students and teachers to overcome the education available today.

Thinking complexity applied to education means unveiling the nature of human knowledge through study, and understanding how this processing takes place in the brain, in the mind, and in the senses; for Morin (2001, p. 33), "the main duty of education is to arm each individual for the vital combat for lucidity", that is the path to facing mental and intellectual errors and illusions, the errors and illusions of reason, as well as those caused by paradigmatic blindness. Understanding lucidly would thus be made possible.

In addressing this approach, with regard to education, Morin (2015b) suggests for this reform to take place at all education levels, and for an alternative to be found regarding the education of teachers so they can break with discipline-based barriers, seeking a culture the author calls authentic, which reconnects "[...] cosmological, physical, biological knowledge and the Humanities" (MORIN, 2015, p. 121).

This study has shown that teachers participating in the course perceived as a contribution by the content for the transformation of pedagogical practice the need to consider a thought-reform approach to education, one that overcomes the fragmentation of knowledge. In addressing student engagement in class activities proposed by the teacher, the group mentioned the importance of interdisciplinarity, collaboration, cooperation, collective work, the role of mediation, and the influence of psychological aspects regarding students' interest in and motivation to learn.

Final Considerations

Understanding complex thinking theory requires a permanent exercise of revising teacher education courses, reconnecting different fields, such as philosophy, history, sociology, biology, psychology, politics, and others which compose curriculum frameworks. Thus, efforts should be made to overcome fragmentation and face the possible errors and illusions that lead human beings to the blindness of knowledge.

Studying complexity theory, especially regarding the "seven complex lessons in education for the future", by Morin (2001), allowed teachers to understand the urgency to introduce transdisciplinary knowledge in educational processes, since it requires a paradigmatic change that is moving too slowly, considering the problems of society, of nature, and of life in the planet.

Assuming that education is really responsible for communicating knowledge, the speed with which technology and information advancements intertwine, invade, and mix with social relationships poses an ever greater challenge to education professionals in terms of keeping up with these transformations and meeting the demand for educational environments that allow student learning with a view to a holistic education of the human being, including regarding students' relationships with others, with the environment and the planet.

The study also led teachers to reflect that thoughts deeply rooted in determinist conceptions, which do not allow reflecting on the possible errors and illusions that exist in development processes and in knowledge itself, can prevent the expansion of human thought towards solving social problems. In education, embracing the perspective of complexity can help to break the barrier of a fragmented, simplifying view that has characterized teaching at all levels. It is therefore urgent to take pathways in search of educating for humanization, for students' growth as people who consider the need to develop responsible citizenship, for building a planetary civilization based on fraternity, on people's commitment to one another, on the inclusion of those who are marginalized, among other challenges. It is an education for life, and therefore it becomes indispensable and necessary that an urgent, paradigmatic change occurs which considers the possible errors and illusions proposed over the history of humanity, in order to build a more human, fraternal and solidary society.

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