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Self-Determined Learning in Higher Education through PBL and Digital/Media

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Abstract

In a 2020/21 course and 2021/22 course, diverse pedadogic resources were applied. Learning-teaching styles usually are considered as a personal feature inherently linked to the teacher. For the presented courses, along the pandemic, not only did we use media resources to solve the issues and limitations for the learning-teaching process in higher education, but we also used an open field of teaching styles, displaying an ecologic style to increase inclusion, NdS, gender disparity, and, overally, reducing the limitations and possible negative impact due to cognitive, social, and basic human needs disparities, as well as starting level differences. The results can be seen in Bache, 2022a; Bache & Ries, 2021a; Bache et al., 2022). Hereby we present the ecologic approach as a way to inclusion and transcend the concept of teaching style to individualization and diversity inclusion (from teaching style as a feature to teaching styles as pedagogic resources) and the complex structres that emerged from the application of pedagogic resources, mostly regarding and linked to SDT and media, through PBL, PALS and Digital/Media resources.

Keywords: education, self-determination, self-organizing structures, curriculum design, neurodiversity

INTRODUCTION

First of all, I am not a physicist, and my area of expertise is physical education, primary education teaching education, and education overally, yet I have taught physics, biomechanics and biomechanics in physical activity and sport, which a priori, one could label as classical physics, but we implemented the courses based on challenge, cognitive diversity and students' main interests, which sometimes includes quantum physics, quantum mechanics, relativity, and statistical mechanics (not to mention regarding consciousness and decision-making, whether applied to sports science and applied sport psychology, or broadly speaking human performance and cognitive performance). For instance, in the learning project at University "Francisco Maldonado" Public College, we introduced students into Einstein's general relativity, and it quickly turned to Planck when talking about physics at very short distances, and, in the end, whether that course or others related to biomechanics, it focused mainly in the understanding of gravity and the complexity after the inclusion of what we called "the fundamental principle of interaction" (Bache, 2024a), which can assist in a solution to the theories of everything (ToE) or the generalization problem in the unification, otherwise $E = mc^2$ (Einstein, 1905) leads to a lack of unities to mass after a dimensional analysis, meaning mass would have no unities, instead of appearing or keeping the unity created for it whether in the thousands or fundamental, as kilograms or grams.

Regarding physics, one can review some works such as Bache (2014; 2023a; 2024a; 2024b) or the understanding of Boyle, Finn, & Turok (2018), Penrose (1965), or the deep understanding of Penrose (1979; 2010; 2020; 2022), Poincaré (1900), von Smoluchowski (1906), or Tod (2024).

Having told that, this work is based on the experience of higher education courses from 2020-2023, the reflection on teaching and learning-teaching settings, and solutions found to diverse problems and issues during Covid outbreak and pandemics, collecting the emerged solutions, and with such complexity that neither traditional models nor the basic media application to the new ones, could have probably been able to solve and succeeded in that, and which has required more than one publication to present them.

In this work we then present, a comprehensive detailed depiction of some techniques and strategies used, and implemented to solve the teaching in the complex landscape presented, as well as simultaneously providing the best learning experience and reducing possible negative effects and impact to cognitive diverse students which exacerbated by the limitations due to the confinement, including those from neurodiversity (Aggarwal et al., 2019; Armstrong & Priola, 2001; Gevins & Smith, 2000; Grandin & Duffy, 2008; Murayama et al., 2015) such as Asperger and other kinds of diversities within the autism spectrum (Grandin & Duffy, 2008; Singer, 1999), and other neurologic and cognitive based features and diversity (Armstrong & Priola, 2001; Deci & Ryan, 1981; 1985; 2008; Gevins & Smith, 2000; Kanai & Rees, 2011).

METHODS

The method was a qualitative approach embedded within a participatory-action-research or PAR (Anisur Rahman, 1985; Argyris & Schön, 1989; Domingo & Gómez, 2014; Fals Borda & Anisur Rahman, 1988; Florian, 1992; López-Urrutia, 2017) applied to curriculum project-design in education, and teaching-reflection within the very teachers-training on their teaching methodology, a.k.a. Emic-Etic (Corona-Lisboa & Maldonado-Julio, 2018; Schön, 1987). Hereby we present a reflection on complex structures as a way to enhance diversity inclusion and students' attention, and enable opposite featured social interaction, trends, and approaches regarding neurodiversity (Grandin & Duffy, 2008; Singer, 1999) within the macro-theory of self-determination paradigm (Deci & Ryan, 2008; Niemiec & Ryan, 2009), including self-determination and intrinsic-motivation (Deci & Ryan, 1985; White, 1959), interpersonal attachments as a fundamental human motivation (Baumeister & Leary, 1995), competence and self-efficacy perception (Bandura, 1977; 1997; Boggiano, Main, & Katz, 1987; Niemiec & Ryan, 2009), and challenge and curiosity as a common feature and motivation in human-beings and the child (Boggiano et al., 1987; Deci & Ryan, 1981). Regarding the teaching methodology for the curriculum project design, in order to enable diversity, engagement, social-engagement linked to achievement goals and competence, and highly-functioning cognitive students and neurodiversity with diverse goals-orientation, we implemented diverse didactic methods and equity-based system or model, that we define in the next section as the main contribution of this work; questions and challenging-approach to engage neurodiverse students; and two different approaches regarding the content: project based learning (PBL) for applied knowledge and skills (and social engagement as well), and diverse models regarding teaching style, feedback and communication in the master class. Regarding the models, it was a highly adaptive teaching style (assessed as integrated, mixed-approach, or ecologic), focusing on participatory, cognitive engagement and peer-to-peer, keeping within the class education, both equity and curiosity as two added didactic values and resources, to the common basic human needs (Niemiec & Ryan, 2009). The models that were integrated in the ecologic model are detailed in the following:

Models

We regard the models (within the pedagogic models scope) as traditional teaching, advanced-traditional teaching (conductist, Skinner, 1954), cognitive (Piaget, 1976), participatory style (Moench, 1986; Fuller, 2002), constructive style (constructivism: Gash & Vonglase, 1978; Maturana, 1978; Piaget, 1976; 1979; Vico, 1710; 1712), and pedagogic (Vygotski, 1926; 1928; 1929), and feedback and role in the teaching-learning process as the main features in order to define each of the aforementioned teaching models. In addition to the previous, the ecologic model (Bronfenbrenner, 1979; 1992; 1999)

not only integrates diverse models and their features, but also the chance to switch and adapt both, whether the class or the teaching structure, pedagogic resources and the teaching-learning process to the context, and the features, didactic techniques or the styles to a particular (or every particular situations), and the teaching model (or particular style) to individual student's learning style, meaning the chance for a more flexible and fluid model for diversity and diverse students's learning style in the class.

RESULTS AND DISCUSSION

The results of both courses and curriculum project design can be seen in diverse published works and communications (vide Bache, 2022a; Bache & Ries, 2021a; Bache et al., 2022). Thence, in the present document we merely report the specific teaching methods and illustrate the complex structures as a result of the implemented curriculum design projects, within the 2021/22 course (FIGURES 1; 4; 5; & 6) and course 2020/21 (FIGURES 2 & 3). Regarding the title we highlight Bache & Ries (2021a) as using a PBL, online teaching and meetings (by BlackBoard) to support and indirectly contribute to their PBL and other projects and skills (including them as lecturers on topics related to curricula-design and specific pedagogic methodology for diversity), and a mock conference (completely online with some groups self-determined deciding to present physically to their group and online to the other groups, in a mixed way) through Zoom, with a highly scope and further degree of remote learning in that course. And a more traditional yet technological approach in Bache et al. (2022) by also introducing a main PBL, and peers- or groups-based work, leading to online communication, teacher-assisted (online) approach, and meetings through Zoom to solve IT or technological doubts, and giving some tips, so the media was focused in virtual assistance, online communication, and peer- and groups-based work (both, online and all the groups together in the same lab/room).

Curriculum Project Design 2020/2021

The curriculum project design is presented in Bache and Ries (2021a) and Bache (2022b). We hereby mainly focus on the complex structures that were enabled to form due the implementation of the mock conference (Bache & Ries, 2021a) and the teaching methods that were also implemented within the 2021/22 course for Biomechanics.

In FIGURE 2a) it shows the master class, which started with a teacher-centered theoretical master class, represented by 101 nodes around a linking node, which is the teacher. While the shell is dark, which represents a rigid tight-moderated structure, in FIGURE 2b) it is also shown the results when the PBL (mock conference: Bache & Ries, 2021a) was implemented, becoming a more complex, fuzzy and adaptive structure. Unlike FIGURE 2a), in FIGURE 2b) the shell is cleared, representing a loose structure, increasing self-determination and shared-responsibility in and within the main learning activity and tasks. Students also gained control, leading and allowing self-management and probably an increase in the feeling of agency. Yet, the figure of the teacher remains, as it is present and still holds some command and supervision of the complex social structure (the teacher is present in the left, anchoring the nodes).

In FIGURE 3, a 101-nodes structure plus the teacher and the question (q) is presented. While perhaps the teacher gains relevance, it is due the emergence of 2 diverse nodes: the teacher, and the question (a challenge). It is the question that probably raises awareness, therefore that 2-nodes emergent structure is noticed by the students (especially NdS and those ego-oriented and achievement-oriented, since it becomes an opportunity to make a point, and/or gain attention from the teacher or the class). Then, the complex structure emerged, yet the teacher can keep the direction and management, after the ignition due to the question (q) that started or allowed communication in and within the class, since FIGURE 3 shows that the question (q) is the anchoring node, and not the teacher. It means that it is the question, and not the teacher, the main node in this structure, and once the communication is opened, answers are usually first to appear. Answers and new questions can emerge. I.e., communication becomes the anchoring-node (it becomes distributed).

In the left, the question (q) made communication (and also the system) distributed and unbounded, only tied by the topic. Above the question (q) the node of the teacher remains to keep and/or re-direct communication towards the topic, or tying creativity, communication, the answers and the new

question to either the correct answer or an open field of possible answers. Perhaps, the most interesting benefit is the emergence of new questions.

Curriculum Project Design 2021/2022

Project Based Learning (PBL) and other active methodologies such as Cooperative Structures (CS), Task Based Learning (TBL) and inverse or Flipped Classroom (FC) are commonly used nowadays in Higher Education (Alves et al., 2012; de Los Rios et al., 2010; Frenay et al., 2007; Jo, 2011; Kerr, 2015; Kiat & Kwong, 2014; Lipson et al., 2007; Torio, 2019), and specifically in physics education and science curricula (Alves et al., 2012; de los Rios et al., 2010; Frenay et al., 2007).

Those and other methodologies arisen as a response and taking into account Piaget (1976) constructivism, and Bandura's proposals about social learning (Bandura, 1971; 2002; Bandura & Walters, 1977), proposals which yielded two main trends: participative systems in learning and education (Moench, 1986), and CS (Johnson et al., 1984; Johnson, Johnson, & Smith, 1991; Kagan, 1989). At that particular time, another, yet a counteractive theory, appeared, offering a more complex picture of human motivation and learning, and emerging as an organismic theory called Self-Determination Theory (SDT), which proposed that students (some students actually) strive for self-regulated learning and self-determination in their goals and their learning process (Deci & Ryan, 1985).

With that complex panorama of human motivation, with theories that proposed socialization and belonging sense as a basic human (and students') need (Baumeister & Leary, 1995) and those that incorporated human goals and the nature of those goals as a main differentiation factor (Ames, 1992a; Nicholls et al., 1989), which assorted the diversity of learners in two branches, those who were goal- and ego-directed, and those who were task-oriented (Ames, 1992a; 1992b; Nicholls et al., 1989), it seems pretty clear that there are not methodologies better than others. Moreover, the implications and relationships between those extreme profiles and the classroom & teaching dispositions, currently known as classroom climate or Classroom Motivational Climate (CMC), since it was studied by Ames (1992a) and Ames (1992b), set, and highlighted, the importance of the "motivational climate" and the adaptation of the teaching style to feature differentiated teaching approaches to different students. In that particular scientific scenery, another theory on education highlighted precisely the importance of individualization, the wavy and veering nature of the context, and the possible need for an adapting teaching style (Bronfenbrenner, 1999).

In 2021, to a 2021/22 course on Biomechanics, a complex landscape was presented: 67 students, of very diverse backgrounds (36% Science backgrounds until high school/A-Level; 64% Social Science backgrounds until high school/A-Level), and diverse cognitive styles, some students in the spectrum (informed) of neurodiversity (Grandin & Duffy, 2008; Singer, 1999; NdS for short), yet some of which that could be ranked as high level on physics and problem-solving skills (Armstrong & Priola, 2001; Deci & Ryan, 1981; 1985; 2013; Gevins & Smith, 2000; Kanai & Rees, 2011), comprised the classroom on physics education.

As a first initiative to the individualized learning, promoting the flexible style to adapt the methodology to different contexts (Ecological System theory, Bronfenbrenner,1992; 1999), the decision was to design a curriculum project that could allow the reconciliation of self-directed pace or self-determination, at least; social-learning and active-methodologies, and the engagement of cognitive diverse students (cognitive approaches, Ausubel, 1960; 1970) to approach the ego-orientation, achievement-goals orientation and the possible social-awkardness, focusing on inclusion, not only of NdS and those with a low level on the subject-matter, but also those that usually are disruptive due to their high level and their possible perception of a pointless course, or because the failure and low grades of the rest could mean distinction and satisfaction for ego-oriented learners (Aggarwal et al., 2019; Nicholls et al., 1989). Besides, one main reason to design the teaching project, and to do it in that particular direction, is that it has been found that, the decision-making perception is related to well-being independently of goal-orientation (Sheldon et al., 2004), and that people learn more in engaging, interactive and communicative activities: especially, they usually learn better when and what they are teaching (about 70% and 90%, respectively, compared to 10% just by reading; Biggs & Tang, 2011). If one knows that, perhaps to engage diverse students may come easier than usually does with traditional and directive approaches.

Now we proceed to define the experience (implementation) recalling the results can be specifically found in the broad publication and communication (Bache, 2022a; Bache et al., 2022). First of all, an ad-hoc assessment questionnaire was completed as initial assessment (to collect data, and information about students' level, backgrounds, motivations, and knowledge on topics such as Einstein's relativity, Hooke's law, and knowledge about physical matter properties and related topics), and the same questionnaire was implemented as a final assessment, after the real exam. A test was also conducted at the end of the course of 6 months. Attendance was neither compulsory nor had weight in the assessment either, so that neither pressure nor compulsory/authoritative paroxysm that may affect some students was introduced.

The course consisted of theoretical classes and practical-technical group-based work in the laboratory, and the initial assessment included some questions to promote focus on the subject-matter, and increase perceived competence and positive motivation, towards task-orientation, and, therefore, to improve CMC.

In the master class, the lessons initially started as a conventional content-focused and teacher-centered lecturing, but, after a transition from guided-instruction to learner-centered methods (engagement), it gradually became a participative-interactive discussion and reflections appeared. Also, a small-group based PBL system was implemented for the practical-technical classes.

So that, the teaching was based on two CS, one small group 12-nodes structure (FIGURE 4), and a one-node complex cooperative learning system or structure (Appeltant et al., 2011; Jacobson, Kapur, & Reimann, 2016), that eventually merged in one complex system beyond the structure presented in FIGURE 1.

To motivate and to engage advanced-learners (either ego- or performance/goals- oriented, or NdS) and those ego-oriented or any other student from low to medium level, cognitive strategies and diverse active methodologies were introduced (Ausubel, 1960; 1963; 1970; Bache & Ries, 2021a; 2021b). Excellence and task-orientation in higher education were also promoted by means of cognitive strategies, ego-reorientation and performance incentivizers (Bache, 2022b).

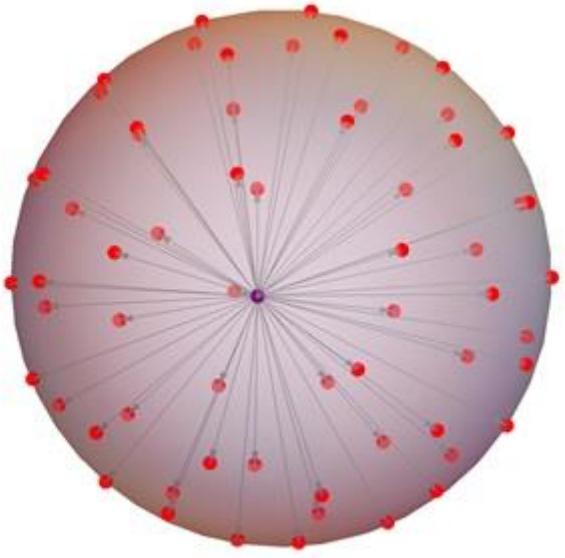
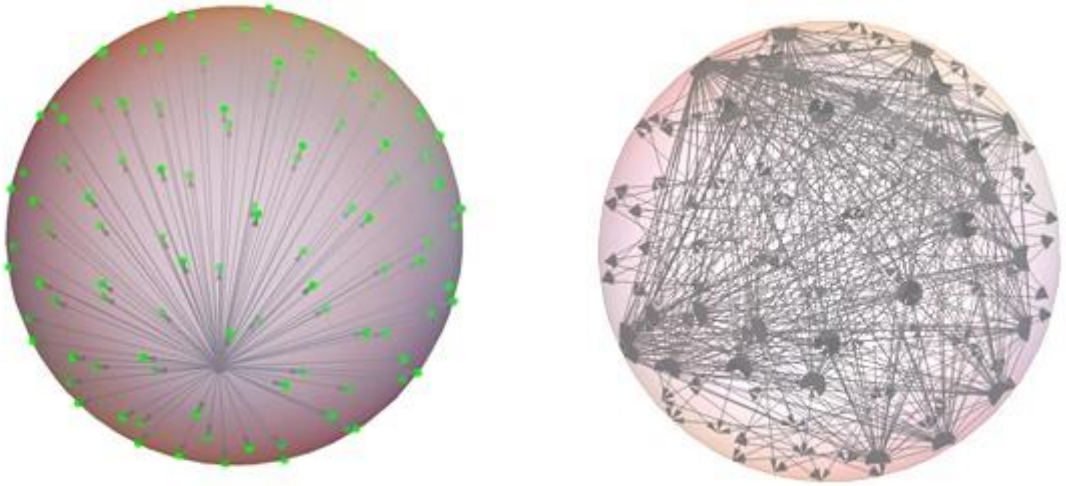


FIGURE 1. It presents a master class, 64 nodes (plus the teacher. Teacher-centered learning). It was implemented in the 2021/22 course (in the beginning, before the unfolding of the project design, see Bache et al., 2022). The teacher in purple in the middle, the closer was a student advanced in physics, as opposition to the teacher itself. Without studying it, it is adventourous to say that either him or the farther linked student on the right was the eminence grease. In the end, both were in high collectively attachment to the teacher and to the class.



(a) (b)

FIGURE 2. It presents a 101 node structure, teacher-centered learning master class (a) and the same class by means of digital media, mock-conference, and PBL (b) While the shell still exists, it is clear and fuzzy, revealing a complex structure with bi-directional links to the nodes. It keeps the teacher (in the left) as the main node, unlike FIGURE 3, it shows 3 or 4 main nodes attracting the connections, and the complexity emerged within an online mock-conference implemented as PBL within the 2020/21 course (see Bache & Ries, 2021a).

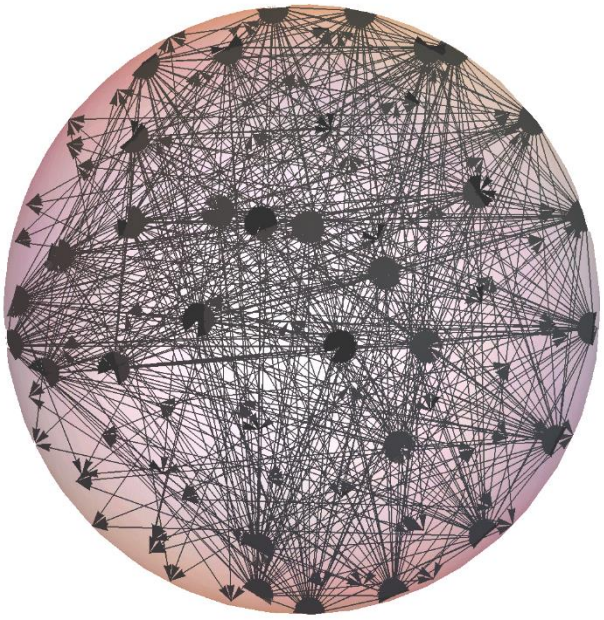
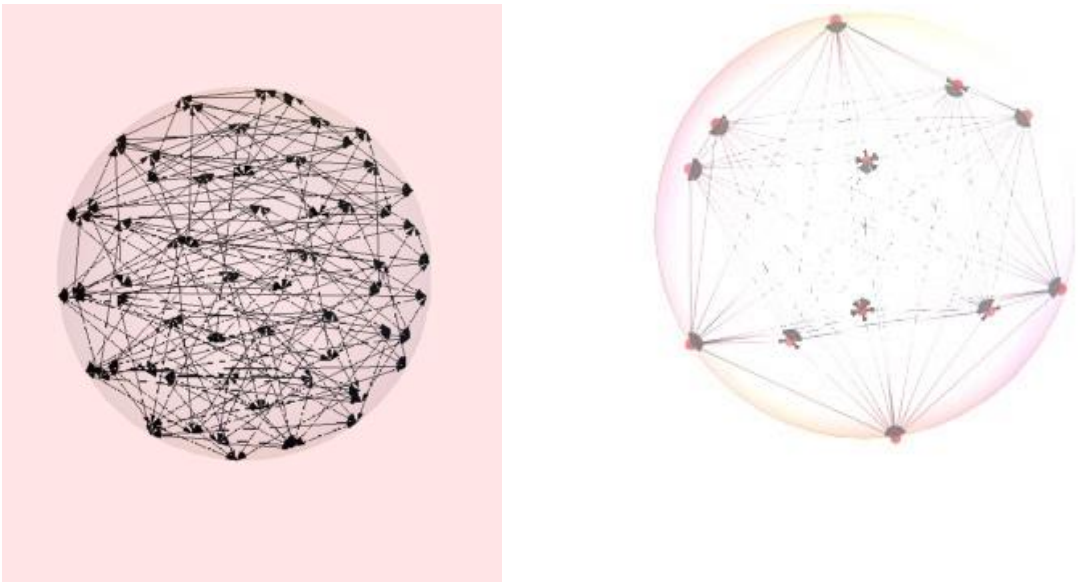


FIGURE 3. This figure presents a complex structure emerged from the 101 node structure (2020/21 course), plus the teacher and the question *q* (both nodes in the left). While the complex structure emerged, it holds some directionality and clear ignition or starting for the communication, which is the teacher (in the left, above the question) and the question (q) placed in the leftmost position. It means that it is the question, and not the teacher, the main node in this structure, and that the teacher is being integrated and incorporated within a closer plane to the students and the learning space, yet keeping a darker sphere than b) in FIGURE 2. A similar structure akin to a mixed state between FIGURE 3 and 4b) emerged after the implementation of the PBL and the pedagogic process herein depicted, yet for the 64 nodes + the teacher + the question (q): a self-organizing structure after PBL (FIGURE 4a) small groups in laboratory PBL plus individual PBL) and PALS (FIGURE 4b) master class peers-teacher-assisted learning plus individual PBL) were incorporated (yielding a structure mixed between FIGURE 4a, 4b and 1).



(a) (b)

FIGURE 4. Both present the structure of the 2021/22 course. In the left (a), it shows the outcome of the PBL and the curriculm design project implementation, which coulored area means that transcends the classroom, and the communication, learning and development falls beyond the spatial domain of the class, teacher, students and local university, towards Academia and society (as presented in Bache, 2023b). In the right, it presents only the 12 node structure (groups) for the PBL, that transcends the classroom, and the sphere has mainly dissapeared, that meaning the emergence of a very complex structure, self-paced, self-directed, and interconnected. On the other hand, it appears a cubed-shape, hyperspace, or geometrical figure, as a representation of a still well-ordered and structured distribution, since the groups were set in the beginning and fixed for the course; showing a well-organized and interconnected complex-structure: fluidity yet organization.

Social learning and cooperative learning aproaches were mainly implemented for practical-technical classes, and for the completion of a PBL-long term project (full-term). Yet, it contributed and was also subsequently, and inherently implemented into the theoretical classes. As it is herein further depicted in the following section, the main values and basic principles were: inclusion, engagement, and participation, essentially incorporated into different kinds of peer-assisted-learning-strategies (PALS), aiming towards task, learning, and meritocracy.

The results were obtained as the mean scores of the exam (80%) and the small groups PBL (20%), and they were compared to the expected mean-scores, set in the normal distribution (vide Bache, 2022a; Bache et al., 2022).

The use of normal distribution of grades for population research in education has been proposed previously, and it has been used according to the reviewed bibliography (Aggarwal et al., 2019; APA, 2013; Fendler & Muzaffar, 2008). The results were shown in a direct comparison, and in a corrected asymmetry model, as proposed by Aggarwal et al. (2019) and Arthurs et al. (2019), meaning that the normal was only used to compare actual results with the expected outcomes according to the normal, yet students received the scores and grades they deserved (none normal or z-scores grading was implemented neither to correct, reduce or increase students marks/grades, but used later instead, only for research comparisons and research purposes). Bell curve has been discussed previously, but the contribution and applications to research in populations of its usage is noticeable since Yerkes and Dodson (1908) experiments.

The research in general, followed the PAR scheme (Fals-Borda & Anisur Rahman, 1988), and the Emic-Etic focus for curriculum development and curriculum-design projects, involving teaching reflective research, evidence-based practice (EBP), and improvement (Corona-Lisboa & Maldonado-Julio, 2018), and was about tying Team Mental Models (TMM), individual performance and tasks, to social cohesion (CO); and individual efficacy to Collective Efficacy (CE), and Coordination (CD) for Team Outcomes (TO) (FIGURE 5), from collective efficacy models (Filho, 2019).

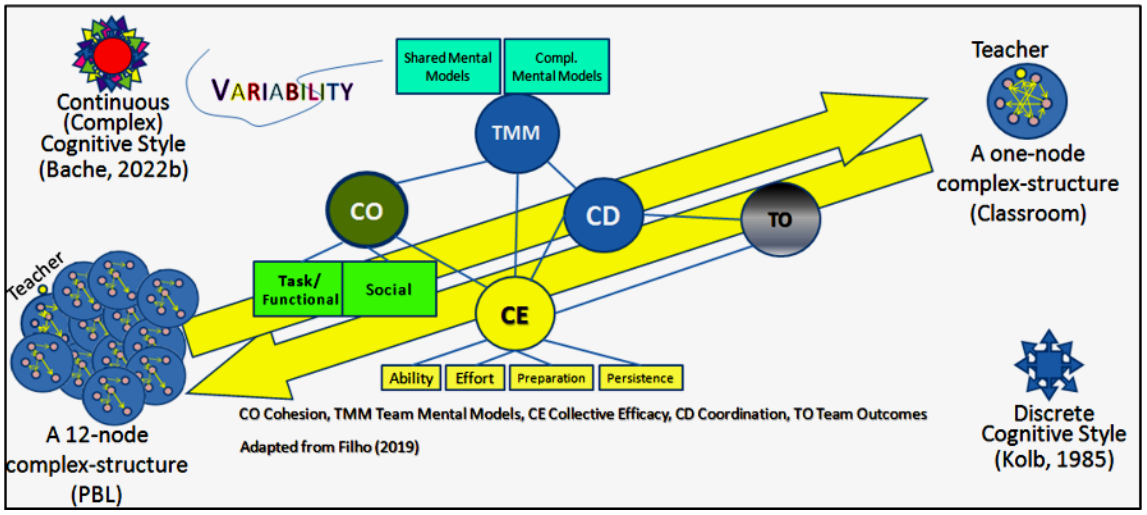


FIGURE 5. Complex System based in two coordinated (CD) complex structures for a learning setting for Team Outcomes (TO), according to Collective Efficacy (CE) model of Filho (2019). It includes mental models and a continuous (complex) cognitive style model based on variability (Bache, 2022b). Also presented in Bache (2022a).

Equity Model

The term equity is a confusing term (Ainscow, 2020) and frequently used interchangeably as diversity and inclusion (Ramiah, Godinho, & Wilson, 2022). The Oxford English Dictionary (2021) defined equity as the "quality of being equal or fair". On the other hand, the UNESCO 2030 Agenda propounded a concept less doubtful or ambiguous, with its proposition for equity as: "leaving no one behind" (UNESCO, 2019). The curriculum-design project was based more on the latter, on a humble proposal and knowing our own limitations, as: "leaving as fewer students behind as possible". (We recognize that some students can decide to drop the course, independently and even before the curriculum-design project was designed, or the course started). Regarding the concept garnered by the Oxford English Dictionary, equality and equity were posited as the same. However, at least in education, one of the main and first values that everybody may agree on is meritocracy. Hopenhayn (2011) pointed out that the recognition of merit, effort and capacity as a form of social mobility, contributes not only to an improvement on motivation and success, but also to the acceptance of the rules of the game of democracy, and encourages citizens to respect shared norms as well. Nonetheless, Rawls (1985) established fairness as a basic principle for equality and equity in education (towards a more accurate term of equality in education, or the concept of equity itself). Hopenhayn (2011) also identified and particularized that principle, as two students with the same potential could have different educational paths and fates depending on their social and economic backgrounds, cultural and educational settings and backgrounds, the quality of education, and many other circumstances beyond the effort and the meritocracy. That is why, on the basis of the offsetting of personal and socioeconomic circumstances proposed by Rawls (1985), Ainscow, Booth and Dyson (2006) included equity as a key element for the embodiment of quality in education, eventually appearing the concept of Ecology of Equality (Ainscow et al., 2012), that connected Rawls (1985) fairness, meritocracy, and offsetting, to the primal concept of quality of education, especially when designing courses, curriculums, and teaching projects. Ainscow et al. (2012) linked those previous philosophical approaches to Hutmacher's (2001) pragmatic approach, on about the socioeconomic and other unjustified circumstances and disparities that may hinder, thwart, or impede students development, success and development, even despite their best efforts and cognitive or intellectual potential; and they merged it to put forward the concept of Ecology of Equity (FIGURE 6), and their perspective of inclusion (Ainscow, 2005; 2007; Ainscow et al., 2006; Ainscow et al., 2012; Booth & Ainscow, 2002; Dyson, Howes, & Roberts, 2004).

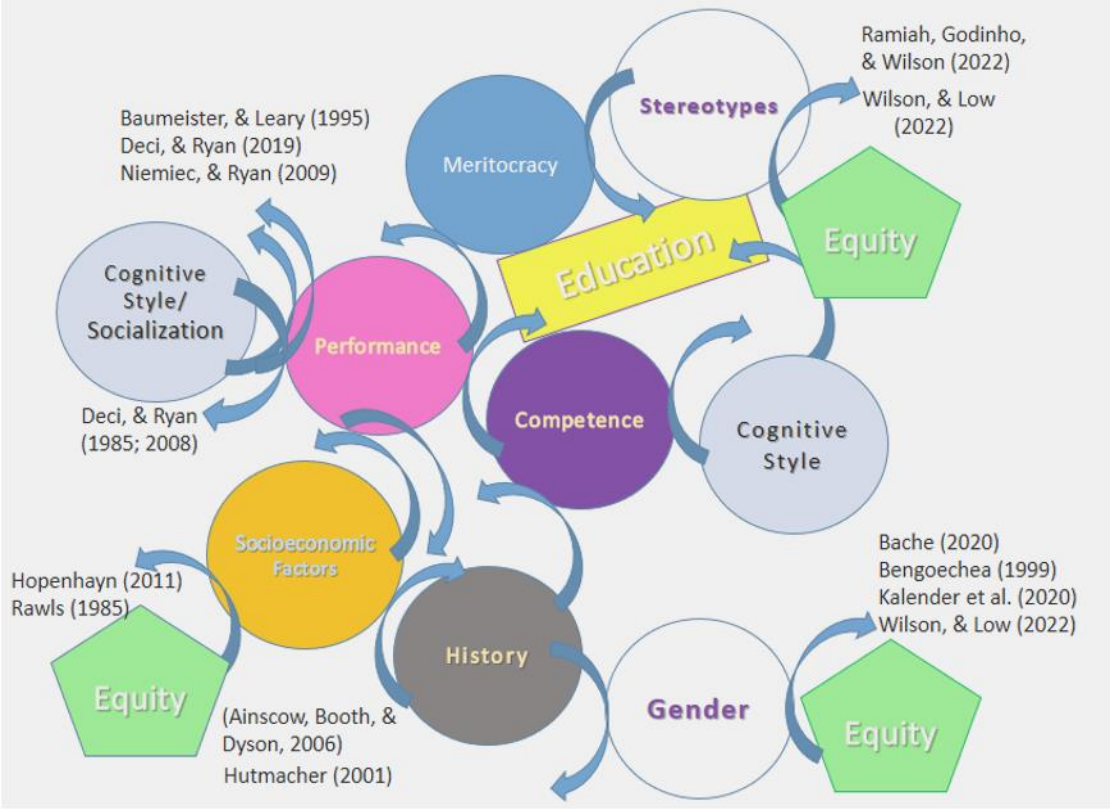


FIGURE 6. Equity model in education based on Ainscow et al. (2012) of *Ecology of Equity*, updated and regarding several proposals (some contradictory, yet it added complexity). As it is a curriculum-design project on STEM, it is highlighted Kelender et al. (2020), Ramiah et al. (2022), and Wilson and Low (2022), works focused on gender, equity, and stereotypes. Yet language and possible teacher's or assessment's bias that may affect underrepresented gender cohorts (Ramiah et al., 2022), e.g. in questions wording (Wilson & Low, 2022), and the disparities in distribution and participation in STEM also play a role (Carrington & Pratt, 2013; Ramiah et al., 2022). It is not encapsulated within lines because it is an open (complex model).

The curriculum-design project, as aforementioned, focused on inclusion (Ainscow, 2005; 2007; Ainscow et al., 2006; 2012; Ramiah et al., 2022; Wilson & Low, 2022). In that sense, the project included equity as a mean of retaining and supporting the success of students (in general), and diverse collectives, especially underrepresented cohorts in STEM (Ramiah et al., 2022; Wilson & Low, 2022) and in the classroom in general, that is to say, taking into account the gender and the NdS, providing a supportive learning environment that recognises and mitigates the disparities that they historically have faced and continue to face, to promote their accessibility, their engagement, their support and their success, instead of focusing on an individual equity group and how to best support them, nor increase their marks, as it was recently advised by Ramiah et al. (2022), following (like ours) the recommendations of Kalender et al. (2020).

It means that the project was intended, and had as a main goal, to create inclusive learning experiences and a supportive and inclusive learning environment, for all the cohorts and students (inclusion, socialization, and individualization of the learning-teaching process). That is to say, integrating the 3 keys to individual learning experience and a more complex proposal than just the self-determination: Autonomy, Competence and Relatedness (Deci & Ryan, 2019), as even the SDT included eventually more social and cooperative approaches (Deci & Ryan, 2000; 2019; Niemiec & Ryan, 2009).

For instance, one "punishment" for interrupting the teacher while talking and answering questions (not being a contribution on the subject-matter or about the topic), or interrupting a debate (breaking the structure and momentum, and losing attention to the lesson) was to face the classroom and explain part of the lesson or answer some questions (in the beginning). But they finally found it engaging, and a challenge (to teach their peers, and to answer some teacher's or peers' questions), so, even while the overlapping, and the disruptive interruptions were reduced and disappeared over time, they still continued taking the lecturer role (especially women, as an empowering tool, when lecturing was found

as a challenging and engaging activity, once mainly each and every student had a high level, close to the end of the course). So, even the "punishments" were applied from the constructivist (Piaget, 1976) and participatory (Moench, 1986) perspectives, and the challenge was preferred after they gathered information and they reached the level enough that allowed them to realize they were able to perform well, and they perceived enough competence and control (Bandura, 1977; Boggiano et al., 1987) for challenge in academic settings, as well (Boggiano et al., 1987).

Another strategy was the so called "el profe ignorante", a pedagogic resource described by Bache and Ries (2021b), intended to engage NdS and high functioning students, and students in general, by means of making purposeful mistakes, so that students (especially ego-oriented, advanced students that could lose attention or drop the course due to the boredom of a perceived low level course, and high functioning and NdS, that could also lose attention due to lack of interest, or the need for challenge), they could engage in helping, correcting, or showing their skills and knowledge, and keep attention into details (mistakes or possible mistakes) and potentiate their focus and attention in the lesson by interaction (it is as a prompted PALS, between the teacher and some particular students). It is a way to check the focus and level of attention paid to the lesson, and to overcome attention disorders, distractions referred by the mindfulness approach (Shapiro et al., 2006), and the waviness and fluctuating nature of attention and consciousness (Alain, 2007; Bregman, 1990; Carr & Bacharach, 1976; Giard et al., 1988; Hameroff & Penrose, 2014; Park et al., 2021; Tessendorf & Kowalski, 2016; Woolf & Hameroff, 2001). Aligned with the teaching project, it was a way to promote the participation, and to ignite the participation and the contribution of the pioneers of the complex structure, not necessarily the advanced students, yet likely the advanced learners of the classroom. Their implication also is proposed to be important to avoid the unconscious affect on attention of background sounds in the auditory scene, which are independent of focus and conscious attention (Alain, 2007; Alain & Izenberg, 2003; Bregman, 1990; Duncan, Martens, & Ward, 1997; Dyson, Alain, & He, 2005).

In the case of gender and NdS, aside from that each and every pedagogic resource implemented was useful mainly for all the cohorts, for these cohorts, taking into account the features and pragmatics that could undermine or reduce NdS performance (Grandin & Duffy, 2008, Singer, 1999), but also female students' performance (Wilson & Low, 2022), specifically was implemented the teaching style, and the communication, being very aware and careful about the language usage (Bache, 2020; Bengoechea, 1999; Parks & Roberton, 2008), and very precise or as accurate as possible in the language usage, both, technical and scientific, and general communication, including unbiased language usage (Bache, 2020; Bengoechea, 1999; Warren, 1986).

Excellence incentivizers consisted on the introduction of a proposal for achieving an extra point associated to cognitive development and a task about a topic on the subject-matter (Bache, 2022b; Bache & Ries, 2021a) which, due to the nature of the PBL, also leads to learning by socialization (Bandura, 2002; Bandura & Walters, 1977) and Learning by Teaching (Biggs & Tang, 2011; Frager & Stern, 1970; also known as "Lernen durch Lehren" or LdL, Grzega & Klüsener; Martin, 1985), since some decided to lecture to their peers about it, and included a process-assessment, or formative-assessment, that led to talk to their teacher; and to task-orientation and performance-orientation over ego-orientation (Duda & Nicholls, 1992; Nicholls et al., 1989) that contributed to a better CMC (Ames, 1992ab; De Volder & Lens, 1983). The introduction of this individual task, the nature of it and the association to 1 extra point was proposed, and let students to decide, so that it promoted (actual goal of the proposal) their decision-making, and their responsibility on the assessment (Anderman et al., 2010; Moreno-Murcia, Lacárcel & Gimeno, 2009), which have been found associated to an improvement of the perceived competence, and motivation (Moreno-Murcia et al., 2009), especially when it was set in a future time perspective and associated to a cognitive-motivational achievement goal (De Volder & Lens, 1983). Once accepted, each student that accepted the challenge could also pick between an artwork with short explanations, or a traditional research and the presentation of a research paper. In any case, since what they accepted was the proposal, each student still could decide to do the task or not (whether they accepted to do so, or not, the task was accepted by majority, but they still kept the individual decision over doing the task or not doing so, by dropping it during the course), keeping in mind the importance of choice, and the decision-making, especially for part of the students (Deci & Ryan, 1985; 2008; Murayama et al., 2015).

In general, either for digital communication or in the master class and the laboratory classes, gamification (Azevedo & Witherspoon, 2009; Deterding et al., 2011) was also implemented to promote engagement, attendance, and a supportive and inclusive learning environment (mistakes are common and were regarded as a learning device to prompt debate and engagement of ego-oriented and advanced students, so, even the teacher made mistakes to prompt their engagement, and LdL, Bache & Ries, 2021b).

CONCLUSION

The main ways to learn are:

- *Learning by doing*.
- *Learning by observation* (vicarious processes).
- *Learning by teaching* (Lernen durch Lehren, LdL).
- *Learning by exposition* (lectures, master class, etcetera). It may include the previous, and it was shown that can become a transitional process to active methodologies, especially if PBL, reflective and inclusive methodologies, and pedagogic resources are implemented.
- *Learning by socialization*. As a main way to learn, as, whether ego-involved and -oriented, or task-oriented, it includes both, the belonging-sense, and also the opposite, self-determined perspectives; and it allows NdS, other cognitive diverse students, disparities and underrepresented cohorts, to be included, to remain focused and oriented to performance and achievement goals (either ego-oriented or task-oriented by nature), and to learn together. We thereby highlight PALS as a way to overcome the main problems adverted by motivation theories, and to solve inclusion (participation), disparity in the starting level when part of the class have a high level on the subject-matter and/or are self-determined learners that can also learn by teaching as well as find it as a motivation to learn and devote more time to learn, while increasing engagement and inherently avouch focus and attention (active interaction, communication and involvement with someone else) either by frequency (learning by elaboration and reverberation), by mindfulness and higher consciousness levels, or both simultaneously.

The use of diverse resources and an ecologic, yet constructive, participative and/or socializing, teaching style, can lead to the apparition of more complex and enriching learning structures, as well as learning environments, and the learning setup and inclusive-display, can lead to the emergence of self-organising structures, with higher attendance, higher results and performance than expected or than individual agents may independently achieve by themselves. Greater engagement, especially if incentivizers for problem/task-solving orientation, cognitive achievement, and excellence pursuit mixed with challenge and low levels of ego-involved teaching attitudes (by teachers), are employed.

NdS were key to the development of the complex structures and the emergence of the self-organising structure, due to their high functioning neurodiversity, their challenge-prone nature, and (whether advanced- or low- starting level in the specific subject-matter) their verbal skills, fluency, declarative knowledge and rhetoric (negotiation and linguistic skills) played a role and were key in that proposal and the teaching project implementation, as they provided to the other students with opportunities to talk and discuss, by starting the dynamics, and either their verbalization of the concepts and rhetorical discussions, or the rhetorical discussions with the teacher, prompted by both (them and the teacher), allowed mainly all students to learn, recover information in a closed (and sometimes open) recursive loop (information and enriched-information flow), to fill and flood the occasional and flickering attention gaps. Finally, the implementation of PBL, media and digital communication and gamification, and the questions (q) that enabled a flow in communication and PALS within the class, allowed global/collective non linear “intelligent” behaviour (or swarm intelligence) emergence.

In a self-organising structure for learning, grades and outcomes equate by themselves, and teachers can teach, learn, and equate outcomes if necessary (yet not recommended beyond formative assessment and consciously associated by students to their attitudes and peers’ attitudes, especially positive attitudes, that are found to be highly transferable and rewarded).

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