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ARTIGOS

Why should Chronobiology be included in teachers' training? [1] [2] [3] [4]

Por que a Cronobiologia deve fazer parte da formação de educadores?

¿Por qué la Cronobiología debería formar parte de la formación del maestros?

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Abstract

Chronobiology studies biological rhythms, the sleep/wake cycle is a rhythm much analyzed in humans. It is a multidisciplinary teaching area, which disseminates scientific studies of interest to education. In this paper, we aim to share our experience in teaching Chronobiology to educators. For this, we offered eight outreach courses at Escola de Artes Ciências e Humanidade (EACH/USP). The methodology included exhibition techniques, practical activities, and a workshop. We used a questionnaire and a critical report as an evaluation. Of the 73 participants (54 women), 35.8 ± 13.0 years, 95.8% recommended the course because it brought a new conception about the functions of sleep and with applications in personal and professional life. Thus, we suggest that the Chronobiology should be part of educators' training.

Keywords: Chronobiology teaching, sleep/wake cycle, scientific dissemination, teachers' training, interdisciplinarity

Resumo

A Cronobiologia estuda os ritmos biológicos, sendo o ciclo vigília/sono um ritmo muito analisado em humanos. Trata-se de uma área multidisciplinar de ensino, que divulga estudos científicos de interesse para educação. Neste artigo, objetiva-se compartilhar uma experiência em ensino de Cronobiologia para educadores. Para isso, foram oferecidos a eles oito cursos de extensão pela Escola de Artes Ciências e Humanidade (EACH/USP), cuja metodologia incluía técnicas expositivas, atividades práticas e seminário. Para avaliação, foram utilizados um questionário e um relato crítico. Dos 73 participantes (54 mulheres), 35,8±13,0 anos, 95,8% recomendaram o curso por trazer uma nova concepção sobre as funções do sono e com aplicações na vida pessoal e profissional. Desse modo, sugere-se que o ensino de Cronobiologia faça parte da formação de educadores.

Palavras-chave: *ensino de Cronobiologia, ciclo vigília/sono, divulgação científica, formação de educadores, interdisciplinaridade*

Resumen

La cronobiología estudia los ritmos biológicos, siendo el ciclo vigilia/sueño un ritmo muy analizado en el ser humano. Es un área multidisciplinar, que difunde estudios científicos de interés para la educación. Nuestro objetivo es compartir nuestra experiencia en la enseñanza de la cronobiología a los educadores. Para ello, ofrecemos ocho cursos de extensión pela Escola de Artes Ciências e Humanidade (EACH/USP), cuya metodología incluyó técnicas expositivas, actividades prácticas y seminario. Para la evaluación utilizamos cuestionario y informe crítico. De los 73 participantes (54 mujeres), 35,8±13,0 años, el 95,8% recomendó el curso porque traía una nueva concepción sobre las funciones del sueño y con aplicaciones en la vida personal y profesional. Así, sugerimos que la enseñanza de la Cronobiología sea parte de la formación de los educadores.

Palabras clave: *enseñanza de la Cronobiología, ciclo vigilia/sueño, difusión científica, formación de educadores, interdisciplinariedad*

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1. Introduction

In this article, we discuss the potential contribution for education of Chronobiology, an area of contemporary knowledge. In this sense, we first explain what Chronobiology is and why we propose to teach this content for education professionals. After, we share our experience from the results reached when offering an outreach course on Chronobiology for educators.

1.1 What is Chronobiology?

The contemporary area of biology focuses on the study of biological rhythms is called Chronobiology – from the Greek *cronos*, time; *biology*, study of life –, aiming to better understand the organisms and their relations with the environment (Rotenberg et al., 2003). The biological rhythms that repeat approximately every 24 hours are called circadian and are the most studied until now. One example of this rhythm is the alternation between wakefulness and sleep (wakefulness/sleep cycle), a frequent object of analysis in humans. The manifestation of the cycle wakefulness/sleep has a temporal relation with the variations during the day in the release of hormones, such as melatonin and cortisol, as well as the core temperature (temperature of the arterial blood in the brain) that, together, play an important role in the endogenous regulation of circadian rhythms. The peak of melatonin release happens in the beginning of the night and, in the case of humans, prepares the organism to the sleep phase (Moore, 1992). In turn, the hormone cortisol plays the opposite role, as its release peak takes place some hours before waking, preparing the organism to wakefulness. The value of the core temperature also follows these changes, in humans it is higher during the day than at night (Bailey & Heitkemper, 1991, 2001).

The times of hormone release in the organism and the variations in core temperature are regulated by an internal time system, which organizes the manifestation of endogenous rhythms and, consequently, the cycle wakefulness/sleep, whose oscillation in humans takes place between the periods of 20 to 28 hours. The endogenous rhythms, on the other hand, are daily influenced by external stimuli which enact their synchronization (adjustment) to the 24 hours in the day, and the environmental light/dark cycle is the main example of an external synchronization agent. However, today we know that other environmental signs also act as

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external synchronizers, such as: artificial lights, feeding times, physical activity, social interaction, school times, and work/leisure. Nowadays, many authors have observed the occurrence of a cycle of wakefulness/sleep at different times during the week, that is, a desynchronization to the daily 24 hours. This takes place when the times imposed by social obligations conflict with the preferable times of individuals, who find difficulties to flexibilize the schedule of their obligations to their preferences and vice-versa (Czeisler et al., 1989; Fuller et al., 2006; Menna-Barreto & Díez-Noguera, 2011; Youngstedt et al., 2002).

These individual preferences are manifested by the different chronotypes, which correspond to how subjects assign their times of sleep, wake up, and do their activities. Thus, people who prefer to sleep and wake up early and feel more well-disposed in the morning are grouped in the morning type (or early chronotypes). Those who prefer later times to sleep and wake up, and feel more well-disposed in the evening are the evening types (or late chronotypes). These characteristics can also be perceived by the temporal times of melatonin and cortisol release and the core temperature, which tend to happen later in the evening types than in the morning ones. People who do not have well-defined preferences, having times between morning and evening, are considered the intermediate chronotypes. The scores on questionnaires about these preferences follow a Gaussian distribution (known as "normal") in a population (Benedito-Silva et al., 1990; Horne & Östberg, 1976), what has led some researchers to attribute a genetic determination to these characteristics. Today this reductionist perspective has been overcome by the notion that these preferences reflect a process of adaptation of the organisms to their environments, being, therefore, the result of the interaction organism-environment, as it involves the playing of genes and their respective proteins (Hur, 2007; Vink et al., 2001) as well as the constant temporal adjustments build during life (ontogenesis). Therefore, they are deeply connected to environmental aspects, including social interaction (Menna-Barreto & Wey, 2007; Roenneberg et al., 2019).

The analyses of ontogenetic traces of the preferences morningness/eveningness in populational studies show that 10-year-old children frequently tend to morningness, but there is a change to eveningness during teenage hood (Andrade et al., 1993; Crowley et al., 2018; Russo et al., 2007). These changes start around 12-13 years old and continue until around 20 years old, the final phase of teenage hood (Roenneberg et al., 2004). In adulthood, the preference for morningness returns and gets stronger in older people (Monk & Buysse, 2014; Park et al., 2002). Besides the variations observed in populational studies we also need to

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consider that these ontogenetic changes follow certain individual limits. In this sense, an extremely evening-type person in teenage hood, despite the reduced tendency with aging, when reaches old age might be considered not as a 'morning- type' when compared to others who were less 'evening-types' during teenage hood. Summing up, all these changes, as well as the individual preferences and the relations between the external factors (environmental and sociocultural) and internal (biological) summed up here, are topics that interest Chronobiology (Andrade et al., 2003).

1.2 Why teach Chronobiology to education professionals?

According to the American Academy of Sleep Medicine, healthy children sleep an average of 9 to 12 hours a night, while teenagers tend to sleep an average of 8 to 10 hours (Paruthi et al., 2016). However, there are indications that individuals in school age do not sleep enough, mainly during teenage hood. In this phase it is common to have a delay in the beginning of sleep, due to the common hormonal changes during this phase and the night-time social activities, which intensify the exposure to artificial light (blue[5]). This delay is followed by an earlier awakening, which can be explained by morning social activities, the start of the classes are the most meaningful commitment of individuals in school age. Because of that, many authors have showed that, since childhood and mainly during teenage hood, a pattern of "restriction/extension" of sleep, with a shorter duration of sleep in school days and extended ones in weekends (Anacleto et al., 2014; Arrona-Palacios & Díaz-Morales, 2017; Carvalho-Mendes et al., 2020). These variations in the duration of sleep can be tolerated within certain individual limits, but a great deviation is concerning. The excessive or restricted duration of sleep is related to serious problems that affect health and well-being (Hirshkowitz et al., 2015).

[5] The blue light corresponds to the short-wave length between 400 to 500nm, Being the band of more intensity and energy potency within the visible spectrum. This light frequency is very commonly emitted by electronic devices, during the night it is able to block the release of the melatonin hormone and, therefore, delay the beginning of sleep. The continuous exposure to blue light can also lead to photochemical damage and trigger the formation of free radicals with serious oxidation damage to the retina. Because of that, nowadays it is very common the recommendation of filters that reduce light in this band during the night.

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The symptoms provoked by the lack of sleep during school days can vary: tiredness, malaise, daytime sleepiness, humor swings, reduced attention and cognitive functioning, among others. Such symptoms, as a whole, can also contribute to reduce school performance (Andrade & Menna-Barreto, 1996; Andrade & Menna-Barreto, 2002; Beebe et al., 2017; Carvalho-Mendes, 2019; De Bruim et al., 2017; Goldin et al., 2020; Kopasz et al., 2010). Brazilian Society of Sleep has made a proposal to change the starting time of classes, from 7:30am to 8:30am. An initiative aligned with the American Academy of Sleep Medicine and the American Academy of Pediatrics (Adolescent Sleep Working Group, 2014, Paruthi et al., 2016) which have also been documented in several countries (Lo et al., 2018; Minges & Redeker, 2016; Wheaton et al., 2016; Ziporyn et al., 2017).

For all this, we suggest the dissemination of information on Chronobiology to education professionals, to help with the effectiveness of these measures. An example of this would be the educational phases by shifts. In Brazil, it is very common for schools to offer Childhood Education and Elementary School in the afternoon shift, while Middle and High School in the mornings. Based on the knowledge of Chronobiology, school management could assemble families, and students, and, through dialogue, raise negation proposals between school and family to discuss the subject. This would allow a more informed perspective on the organization of school schedules in the different educational phases and would, even, create a bridge with sociocultural aspects, mainly the role of clock – as markers of commitments and/or social time- which would end up establishing a relation of tension with Chronobiology. Thus, its teaching would not be just one more object of educational knowledge, but also a social practice (Elias, 1998; Middleton, 2014; Silva, 2019; Souza, 2018; Squarcini & Esteves, 2013). Nowadays, the inadequate sleep incidence in our capitalist society – in which the means of production aim to profit lead to tiredness– has been producing an increasing number of complaints about sleep among young people and adults, who frequently seek specialized medical clinics (Crary, 2013; Han, 2015). In this perspective, the knowledge on Chronobiology can make people reflect about the organization of social and school times, assuming the pros and cons of their choices. In this context, decisions are more solid, as they are taken from an awareness of the problem.

Similarly, the repercussion of this knowledge will reflect inside the classroom, for instance, in the common naps in the first classes among Middle and High schoolers. These naps create stigmas and teachers can become demotivated or punish and discipline students,

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conflicts that can lead to school drop-out. By knowing chronobiologic concepts, the teacher could raise students to the position of critical observers of their everyday life, regarding the working of their bodies and also their needs (Freire, 1997). Simple attitudes, like guiding students on the use of electronic media at night, due to their influence on the cycle wakefulness/sleep, on the perception of their sleep patterns, diet, the moment they fell more aware and willing to study, to work out, for example, can contribute strongly to improve their life quality, and this also will reverberate in a better school performance (Goldin et al., 2020, Louzada & Menna-Barreto, 2003; Mendes, 2013). Therefore, learning can be understood as a process of personal appropriation of the subject, a meaningful process; a builder of meaning and change (Ausubel, 2003; Piaget, 1999; Vygotsky, 2000, 2001).

Having this in mind, we have conducted some interventions, such as lectures, courses, and research projects in school, disseminating methodologies and tools to capacitate education professionals to work concepts of Chronobiology. In this article, our main aim is to share our experience, derived from outreach courses in Chronobiology, guided towards Teaching degree undergraduate students and professionals in education and health. To do so, the specific objectives were to evaluate participants' opinion and select some proposals of seminars presented during the courses that portray practices of Chronobiology teaching in each educational phase. Our hypothesis is that participants will have a positive evaluation of the courses, as well considering pertinent the teaching of contents on Chronobiology for educators.

2. Materials and Methods

2.1 About the courses: organization and structure

The first outreach course took place in July 20016 and, since then, it was offered twice a year, completing 10 editions in January 2021. In this work, we discuss the results gathered until the 8th edition, offered in January 2020. The last two happened on-line, due to the conditions of social isolation and their results will be shared in future publications.

The enrollments for the courses were done through the digital platform of *Secretaria de Cultura e Extensão da Escola de Artes Ciências e Humanidade* (EACH/USP-Secretary of Culture

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and Outreach of the School of Scenic Arts and Humanities), which also publicized the event. The advertisement on the courses also took place in social media and electronic messages sent for secretaries and educational bodies. To enroll, participants should send a certification that they had finished their undergraduate studies or an enrollment declaration on this level, personal documents, and a letter of interest. People enrolled were selected according to the following criteria: 1 – To be a professional in education, enrolled in a Teaching degree, Bachelor degree, Pedagogy, or similar areas. 2 – Be a professional in the health area with an interest in education.

The study and courses were conducted in the university (EACH/USP). The teaching model adopted was socio-interactionist, as the daily physiological changes and during human development were discussed and understood as inseparable from the socio-cultural context of the individual. Besides this, we have outlined the relation of the concepts discussed during the course with participants' previous knowledge, acquired by popular culture, to attribute new meanings to this information. Thus, the knowledge associated with average values and to the normalcy of certain biological variables was updated, following the information on Chronobiology. For example, the daily average of sleep considered as "normal" to a healthy life, according to Chronobiology, might have individual variations, as well as change during the ontogenesis, among other variables (Ausubel, 2003; Vygotsky, 2000, 2001).

The methodological resources used to develop the activities of the course were exposition techniques, practical activities, and interdisciplinary pedagogical suggestions to teach Chronobiology targeting students from Early Childhood Education until High School. As a practical activity, participants were invited to develop a class plan, which should approach the teaching of Chronobiology in different educational phases (Early Childhood Education, Elementary and Middle School, High School, and Youth and Adult Education). The class plan was presented as a seminar on the last day of courses (Table 1). The proposals were described through an observational qualitative method and structured depending on the class theme, objective, instruments, and procedures used. We selected some seminar proposals, according to the target audience (age range), to contemplate each educational phase. The proposals were detailed in the session of results in this article (Table 3). All activities of the course were created according to the official school curricula (Parâmetros Curriculares Nacionais, 1997; Parâmetros Curriculares Nacionais, 1998; Parâmetros Curriculares Nacionais. Ensino Médio 2000a; Parâmetros Curriculares Nacionais. Ensino Médio, 2000b; Base Nacional Comum

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Curricular, 2018). On Table 1, we have a detailed description of the syllabus and practical activities, distributed in 4 consecutive days in a total study load of 20 hours.

Table 1 – Syllabus and practical activities distributed by each course day

	Syllabus	Practical activities
1.st day	Introduction to Chronobiology; Cycle wakefulness/sleep; memory and learning;	Sleep diary and identification of chronotypes
2.nd day	Ontogenesis of biological rhythms: observing the changes that take place in each educational phase; Guidelines to present seminars;	Levels of alertness before and after a ludic activity, involving music
3.rd day	Themes of Chronobiology based on Brazilian educational curriculum with suggestions of activities; Human and Biological Sciences; biological rhythms and health: a personal reflection;	Workshop Time in Live. Available at: http://www.each.usp.br/crono
4.th day	Debate on the results of practical activities; presentation of seminars; participants' critical report and closure.	Construction of an actogram

2.3 Instruments and procedures to evaluate the courses

The courses were evaluated through the analysis of two instruments.

The first was a questionnaire, created by the *Secretaria de Cultura e Extensão* [Secretary of Culture and Outreach] of the university (EACH/USP) and made available by e-mail to enrolled participants after the end of the courses. The questionnaire, aiming to evaluate the activities offered by the program, did not have the participants' identification, who were free to send or not their evaluation.

The questionnaire was structured in 4 themes (content, evaluation, personal, course) with 3 multiple-choice questions each, in a total of 12 questions. All of them offered 5 alternatives of answers (terrible, bad, regular, good, or great), with the exception of question 3 of the theme "Personal" which proposed 2 alternatives (yes or no). In the section results (caption of Figure 1), we have the description of each question by theme. After the period of evaluation, the Outreach Secretary provided the questionnaires to the responsible researcher,

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who analyzed quantitatively the compilation of their results. To do so, the answers of participants were submitted to a descriptive analysis to quantify the percentage distribution of answers chosen in each question, and the chi-squares test (x^2) was used to see if there were differences in this distribution.

The second tool used was the method of critical report. The reports were written in-person by the participants on the last day of the course (Table 1) and structured from the 4 guiding questions, prepared by the responsible researchers. The questions aimed to evaluate the following areas of the courses: meeting personal expectations, course uses, general perceptions, and future suggestions. We conducted a qualitative analysis and, for each area evaluated, we selected some excerpts that were mentioned with more frequency by the participants, who were completely free to do or not their report, without needing to identify themselves.

All procedures were conducted during the courses according to the ethical research recommendation, report number 4 535 977. Participants were informed about the researcher's interest to write a scientific article about the course and those who agreed to participate would have their data included in their analyses.

3. Results

In the 8 editions of the course, we had 73 participants (54 women) with an average age of 35.77±13.02, with an average of 9.1±4.9 participants per course. From this total, 21 participants were undergraduate students in Teaching degrees; 13 recently-graduate professionals in education (less than 3 years working); 36 professionals with more than 3 years of work, among them educators and health professionals; and 3 did not identify themselves.

In Figure 1, we illustrate the percentage distribution of answers of each question of the Evaluation questionnaire and according to the levels of satisfaction (terrible, bad, regular, good, great/yes or no). As nobody chose the "bad" level, this item was ignored in the analyses.

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Question 1 of the personal theme (Figure 1C) aims to know the previous knowledge of participants to follow the course. In this question, the regular level reached the highest percentage of answers and was marginally meaningful compared to the other levels (x^2 = 7.83; p = 0.05). We observed in question 3 (Figure 1C) that the percentage of participants that recommend the course was higher than those who do not recommend it (x^2 = 40.33; p < 0.001). In the other 10 questions, the percentage of individuals that chose the level 'great' of satisfaction was greater was significantly different compared to the levels 'good' or 'regular'. Figure 1A: Question 1- Proposed objectives (x^2 = 73.62; p < 0.001), Question 2- Adequacy of content to study hours (x^2 = 20.38; p < 0.001), and Question 3- Didactic material used (x^2 = 39.50; p < 0.001). Figure 1B: Question 1- Instruments and procedures to evaluate learning (x^2 = 34.88; p < 0.001), Question 2- Relation of evaluation content with program (x^2 = 40.62; p < 0.001), Question 3- Time to solve evaluations (x^2 = 15.50; p < 0,001). Figure 1C: Question 2- Satisfaction level (x^2 = 59.38; p < 0.001). Figure 1D: Question 1- Course duration (x^2 = 12.88; p < 0.01), Question 2- Continuity and organization (x^2 = 39.50; p < 0.001), Question 3- Infrastructure (x^2 = 8.38; p < 0.05).

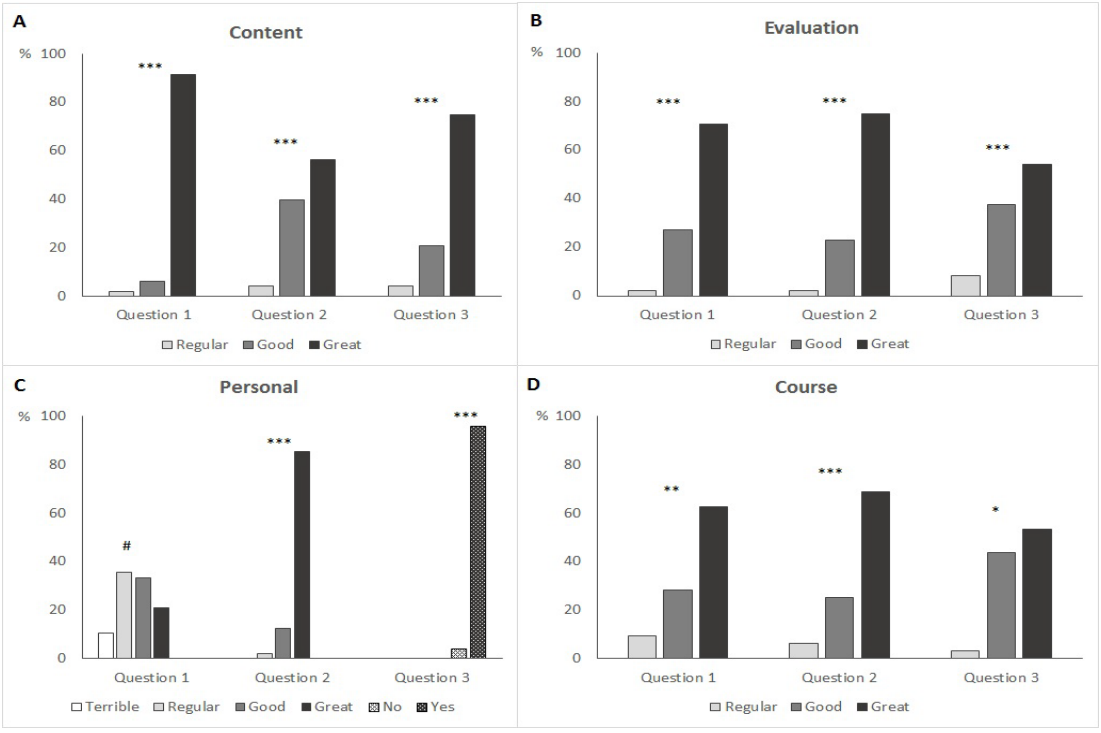

Figure 1 - Percentage distribution of participants' answers in the Questionnaire of course evaluation per theme (Content, Evaluation, Personal, and Course)

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A: Content – Question 1: Proposed objectives (x^2 =73.62; p<0.001). Question 2: Adequacy of content to study hours (x^2 =20.38; p<0.001). Question 3: Didactic material used (x^2 =39.50; p<0.001).

B: Evaluation – Question 1: Instruments and procedures to evaluate learning (x^2 =34.88; p<0.001). Question 2: Relation of evaluation content with program (x^2 = 40.62; p<0.001). Question 3: Time to solve evaluations (x^2 =15.50; p<0.001).

C: Personal - Question 1: Previous knowledge to follow the course (x^2 =7.83; p = 0.05). Question 2: Satisfaction level (x^2 =59.38; p<0.001). Question 3: Course recommendation (x^2 =40.33; p<0.001).

D: Course - Question 1: Course duration (x^2 =12.8; p<0.01). Question 2: Continuity and organization (x^2 =39.50; p<0.001). Question 3: Infrastructure (x^2 = 8.38; p < 0.05).

Chi-squared test: #p=0.05; *p<0.05; **p<0.01; ***p<0.001. Source: Created by authors based on the answers given in the questionnaire of course evaluation.

On Table 2, we present some excerpts of some critical reports organized in four areas: meeting personal expectations, course uses, general perceptions, and future suggestions. Each area received a comment from the authors.

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Table 2 - Excerpts of some critical reports written by participants and organized according to the four areas commented by the authors.

Analyzed area and comment	Excerpts of some participants' critical reports
Meeting personal expectations: The course allowed the understanding of Chronobiology. We also perceived that the subject was considered new for many participants.	*"My expectation was met, because I got knowledge on a subject, so far, unknown".* *"The contribution of the course was effective, because I learned different concepts and multidisciplinary use".*
Course uses: By the reports, we also perceived that the course was adequate to be applied in the personal life and professional practice of participants.	*"these days I discovered myself. Now I know more about how to respect my limits, that of others, and improve my work as an educator".* *"These concepts connected to the reflections I did during the whole course raised a new perspective on my personal life as well as my pedagogical practice".*
General perceptions: Many participants reported that the course brought a new concept on the functions of sleep, its importance, as well as on the changes that take place during development.	*"I believed that sleep was an irrelevant physiological need and little related to pedagogical development. I thought it was simply a moderator of organic functions not associated with cognition".* *"I had no idea about the different physiological needs throughout our development. This is why it is so important to disseminate this information".*
Future suggestions: The main suggestions present in the reports were regarding the dissemination of the course.	*"Maybe you should have a different name to disseminate the course, as it is an interdisciplinary knowledge still unknown in the area of education. For example: to know you time and the time of your student".* *"The course could start one week earlier (…) Many professionals resume their activities in the last week of January".*

We also selected five proposals of seminars, showing teaching practices in Chronobiology for each educational phase. In each proposal, we describe the objective, instruments, and procedures on the theme (Table 3).

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Table 3 - Description of the theme of each seminar (objective, instruments and procedures) selected according to each educational phase

Educational phase	Description of the theme of each seminar
Childhood education Theme: Individual differences and essential care	Objective: Reflect about the organization of children's sleep schedule due to the activities performed by the parents and the school. Instruments and procedures: Diary of activities used by teachers and parents, which would work together in the record of sleep schedules and the main activities done by children. At school, the teacher would complement the proposal of didactic activities, making children recognize their body needs through music, dance, arts, and nap, presenting the differences regarding activity and rest.
Elementary and Middle school Theme: Rhythms of nature	Objective: Understand that nature has different rhythms, which are influenced by external factors, such as the movement of the planet. Instruments and procedures: Signs printed on bond paper, with information of cyclic events. Examples: Hibernation, body temperature, flourishing of plants, tides, menstrual cycles, etc. The signs should be grouped in three categories, according to the time spent at each event to complete itself. After the activity, the group related these events with the movements of rotation and translation of the Earth and the Moon and explained the influence of these phenomena on the life of living beings and the manifestation of different rhythms.
High School: Biological Sciences Theme: Biological diversity	Objective: Relate the biological rhythms of different organisms with the adaptation and survival of living beings to, then, introduce the study of levels of organization of living beings. Instruments and procedures: Envelopes with images of different living beings (bacteria, protozoa, fungi, animals, and vegetables) were distributed among the groups, who should make a research to check the possibility of relating these bodies with some rhythmic characteristics such as gestation time; reproduction, disease cycle, seasonality; sleep habits, diet, etc. After, a discussion about the differences observed between the organisms with the adaptation and survival of species.
High School: Human Sciences Theme: Individual and culture	Objective: Discuss how sleep is understood in different cultures. Instruments and procedures: The structure of the class was divided into two phases: 1st) Discussion on the way of sleeping. Questions to reflect "Do all cultures sleep in the same way? What are the different ways to sleep and objects used during sleep? What are the preconcepts about the times of sleeping and waking up?" 2nd) Observation of individual rhythms using a sleep diary. After recording, we proposed activities in which the group should discuss naps, dreams, difficulty to sleep and wake up.
Youth and Adult education (YAE) Theme: Human beings and Health	Objective: Identify individual differences and during life regarding sleeping patterns and performance of activities. Instruments and procedures: The structure of the class was divided into two phases: 1st) Assembling a timeline with information on times of sleeping and waking up, the main activities (for example: study, work, leisure, etc.) and the times of greater disposition in different life phases (childhood, teenage hood, adulthood). Activities in circle with the presentation of each timeline, followed by a discussion based on the observed differences. 2nd) Introduction to the basic knowledge of Chronobiology. The group ended with a discussion on the importance of knowing and caring for their own bodies, as well as organizing their daily activities.

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4. Discussion

The interest of several researchers to analyze the influence of school time in the cycle wakefulness/sleep of children and teenagers have resulted in many publications in international and national scientific literature in the area of Chronobiology, whose discussions also involved education professionals (Adolescent Sleep Working Group, 2014, Andrade & Menna-Barreto, 1996, 2002; Blunden & Rigney, 2015; Carvalho-Mendes et al., 2020; Gruber, 2017; Lo et al., 2018; Minges & Redeker, 2016; Paruthi et al., 2016; Silva, 2019). Though questions such as these have already been discussed and are known in the academy, we suggest a greater dissemination to the population in general and, mainly, among educational professionals. In our results, Chronobiology was frequently described as a novelty, an unknown subject until then (Table 2 - Meeting personal expectations and Future suggestions). Many even did not know about the physiological changes that take place during ontogenesis, the roles of sleep, as well as their relations with cognitive and pedagogical performance (Table 2 – General Perceptions). We have also perceived in the questionnaire of evaluation of the courses that 35.42% of participants indicated a regular level of previous knowledge in Chronobiology (Figure 1C; question 1), which was higher and marginally different compared to the other levels ($p=0.05$). This was a personal perception of participants regarding the information discussed during the course, considering that no detailed analysis of previous knowledge was conducted, which points out a limitation of our study. Despite this, this was the only question of the questionnaire that the level "terrible" was indicated by participants (10.42%).

On the other hand, we observe that, though it is a new topic, the course allowed participants' reflection, leading them to consider the importance of knowledge in Chronobiology and its dissemination to educators, that is, they understood its multidisciplinary application (Table 2 – Future Suggestion, General Perceptions, and Personal Expectations). We also perceived that participants were involved with the activities of the course, for example, in the presentation of seminars (Table 3) and, even more, they reflected on the relation of the contents learned in the course with their personal and professional routine (Table 2 – Course use). This lead us to infer that the teaching of Chronobiology, as proposed in our teaching methodology, was meaningful (Ausubel, 2003; Vygotsky, 2000, 2001) and that the objective of the course was reached, considered that the participants

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indicated a great level of satisfaction in the following aspects evaluated in the questionnaire (Figure 1): content (objective, study load, didactic material), evaluation (instruments and procedures, adequacy to program, and available time), personal (satisfaction level), and course (duration, continuity, and infrastructure). Besides this, 95.8% of participants recommended the course (Figure 1C, question 3). In general, we have seen that our results were positive. However, it is important to highlight that the size and representativeness of our sample do not allow us to generalize them to all educators in the country.

Due to this limitation, we would like to highlight other previous experiences in literature which evaluated the effect of education programs on sleep held in school, before and after the intervention. Gruber (2017) analyzed 15 studies published worldwide on the effect of these programs and, despite the methodological differences regarding our outreach experience, we have noticed that our conclusions were also positive regarding the impact of these programs on the sleep behavior, knowledge, and health results. The studies also discuss that teachers' participation is essential, because they will guide students in the classroom. Out of the 15 studies, 3 were published in Brazil, and the results, in general, corroborate the previous ones. However, the authors similarly describe limitations related to short periods of intervention in schools, pointing out that many changes require a change of habits already consolidated, such as the use of electronic equipment until late at night in school days. Despite this, they point out the importance of developing educational interventions in school environments towards the well-being of individuals (Azevedo et al., 2008; Sousa et al., 2007; Sousa et al., 2013). In general, no work in this area reports the continuation of changes after the intervention period, what was also not seen in our study (Bakotic et al., 2009; Blunden & Rigney, 2015; Díaz-Morales et al., 2012; Gruber, 2017; Souza et al., 2016).

Together, these experiences reinforce the need to insert the teaching of Chronobiology for educators, aiming to reach more concrete changes. Nowadays, in Brazil, this area of knowledge is developed in undergraduate and postgraduate courses, normally in the Biological area and similar. This seems to be a gap in our Teaching degrees and in Pedagogy itself, considering that themes in which it would be possible to teach Chronobiology are part of the curricula of Brazilian K-12 education (Parâmetros Curriculares Nacionais, 1997; Parâmetros Curriculares Nacionais, 1998; Parâmetros Curriculares Nacionais. Ensino Médio 2000a; Parâmetros Curriculares Nacionais. Ensino Médio, 2000b; Base Nacional Comum Curricular, 2018). Regardless of being in the academic or school sphere, knowledge is not

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static, but full of transformations, each having a specific set of characteristics, when taught to individuals. The theory of Didactic Transposition classifies knowledge in three levels, according to the social group composed by it: *wise knowledge* (scientific community); *knowledge to be taught* (representatives of the educational system) and *knowledge taught* (school community). These social groups have different objects, however, they all converge to disseminate and/or knowledge of different information. Within this perspective, we suggest a didactic transposition of Chronobiology contents, because this tool in science didactics can help us in this pathway: to transform knowledge from its origin (wise knowledge) until the classrooms, when the content reach students though the teacher (taught knowledge) (Achiam, 2014; Andrade & Bertolucci, 2011; Chevallard, 1989; Mathias et al., 2006).

This way, the extension of these educational experiences in the family context can build a dialogue bridge among the whole school community. The seminars presented during our courses (Table 3) are practical examples of this use, with them we can see that Chronobiology themes can be discussed in the classroom in all educational phases. However, for this to happen effectively, we need educational policies concerned with the insertion of Chronobiology in teacher education, with the support of authors of school manuals who are willing to include Chronobiology contents in didactic material, as well as academics interested to disseminate this knowledge (Azevedo et al., 2008; Cambras & Díez-Noguera, 2019; Carvalho-Mendes, 2019; Finimundi et al., 2013; Gruber, 2017; Louzada & Menna-Barreto, 2007; Souza et al., 2016).

The insertion of this knowledge in science teaching can also contribute to the model of scientific literacy, to develop in the student the competence to investigate the needs of their bodies through daily observation and, more, to question and even debate with colleagues and relatives on the importance of respecting or not these needs faced by daily decision-making processes. The abilities associated with this scientific know-how can allow students a greater autonomy to interact with people around, a result of their awareness that the environmental and social factors influence the cycle of wakefulness/sleep and that the physiological needs are different in each organism and throughout development. In this sense, the concept of scientific literacy is supported in the understanding and interpretation of scientific knowledge by students, to form citizens able to actively and critically act in society (Freire, 1997; Santos & Mortimer, 2000; Sasseron & Carvalho, 2011).

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In Latin America, we already had some conquests in this sphere such as the appointment of Argentinean biologist and researcher Diego Golombek, also known by his work in scientific dissemination in the area of Chronobiology and science in general, to become the executive director of *Instituto Nacional de Educación Tecnológica* (INET- National Institute of Technical Education) in his country. This positive news motivate us to continue to disseminate Chronobiology in the education field in Brazil, as well as our results in university outreach courses. Surely, only our experience and the previous others described in the literature are not enough to promote social changes, not even in the area of education. Besides this, by the limitations pointed out during this discussion, we suggest for future works the longitudinal evaluation of these experiences, as well as its direct application in undergraduate degrees (Teaching and/or Pedagogy). Finally, we believe that our experience contributes to a critical reflection and a social mobilization in the universities seeking to update knowledge, so that more people can think about the subject and even share these challenges, even proposing other creative solutions. Thus, our initiative is timely, with a theoretical importance and practical meaning for scientists and educators, respectively.

5. Conclusion

From our experiences, we can conclude that Chronobiology was considered a new area for a great number of participants. Furthermore, the results of the courses were positive, because participants recognized the importance of teaching it in school context. They have recommended the course and considered it was meaningful, because it allowed a shift of awareness on the functions of sleep, its importance, and also the viability of applying its contents in their personal life and professional practice. The themes presented in the seminars show the possibility of teaching Chronobiology information in the classroom, since Childhood Education, therefore, not limited to Higher Education. However, for this to take place there will be a need to create educational policies that seek to implement a subject of basic Chronobiology to Teaching and Pedagogy undergraduate degrees. Initiatives such as these can reach more effective changes by contributing to disseminate this knowledge for the population in general and, mainly, for education professions, considering that this need was also identified in our results.

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