

# Sleep and perform, exploring the relationship between lucid dreaming and creative performance: a PBL proposal

## Abstract

The creative performance, as well as other exclusively human capabilities will be the qualities that the future workers must have, due to what has been called the fourth industrial revolution. Therefore, teachers have the obligation to investigate and innovate on new techniques and implement methodologies that promote these skills. The Project-Based Learning (PBL) methodology has shown great benefits in this regard, and there are innovative fields, such as lucid dreams, which could be a new tool for enhancing creative performance. Therefore, the aims of this work were to review the related literature to verify that an intervention using the PBL methodology could be combined with research in lucid dreams in an applicable, relevant, well-founded, coherent, and original way. The second aim was to develop an ABP proposal with these elements to enhance the critical skills that students will need in the future, with special emphasis on creativity. We conclude that this proposal meets the revised characteristics, and we include the design of the proposal, gathering these elements. As a continuation of this work, we intend to carry out an investigation analyzing the data that may be offered by different classrooms that apply the program.

**Keywords:** active learning, creativity, innovation, lucid dreams, performance

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## Introduction

Although the relationship between sleep hygiene and academic performance in adolescents is widely known,<sup>1</sup> other more relevant and philosophical questions, such as where consciousness resides, remain undiscovered. In the same way, if we talk about dreams in the plural, their understanding has only just begun. Among the methodologies used to investigate them, some works have used novel techniques, such as the SL<sup>2</sup> to be able to receive information directly from the researcher without losing the dream state. A difficult question to answer related to this is if we lose consciousness when we are asleep.

The definition of sleep usually refers to a transitory state of behavior that is accompanied by a lack of sensory perceptual capacity and a lack of response to the environment.<sup>3</sup> As we can see, consciousness is not alluded to here, even though this is a critical concept for its definition, and this may be because, as we said, it is also a conflictive aspect.

Although it may seem like a loss of consciousness, in reality there are neurophysiological correlates that would not support this hypothesis,<sup>4</sup> at least in part, since the pattern of synchronous activity found in the thalamocortical system, characteristic of consciousness, is also present during REM (Rapid Eye Movement) sleep.<sup>5</sup> This would be consistent with the perception we have of dreams, as if they were a conscious reality. Thus, consciousness would not have to be subservient to the waking state. For more information on neurological theories related to consciousness, we invite the reader to consult the article by.<sup>6</sup>

In relation to this, some authors try to explain the phenomenon of dreams as a conscious experience due to the activation of certain brain structures.<sup>7,8</sup> As the reticular system, the thalamus, the amygdala, the basal ganglia and the associative cortices are in operation in the REM phase, the same experience could be produced as when we are awake. The difference would be that the information with which they work

is not that offered by the sensory organs, but rather it would be self-generated by the brain.

It is this activity that would generate dreams, which usually appear during this phase as a consequence of the activation of what has very recently been called the hot zone.<sup>9</sup> So, dreams would be a kind of “mental activity that occurs in sleep characterized by vivid sensorimotor images that are experienced as waking reality, despite distinctive cognitive features such as the impossibility or improbability of time, place, person, and circumstances.” actions<sup>7,10</sup>

Therefore, we could say that the act of sleeping is not necessarily linked to a complete loss of consciousness (especially in the REM phase). Even the popular statement that the brain shuts down while we sleep is not true, since it remains, as we have seen, almost the same. asset, especially in the REM phase (also called paradoxical sleep phase, similar to that of wakefulness).<sup>11</sup>

In REM sleep, not only is the probability of waking up greater, but in general the dream production occurs there, having cataloged this REM phase as exclusive to the phenomenon. But, recently, evidence has been found that this is not the case. Siclari et al.'s team<sup>9</sup> measured brain activity using an Electroencephalogram (EEG) while a group of subjects slept. Thanks to this, they were able to verify that those who reported having dreamed, although they were mostly in the REM phase, were also in the NREM phase. These same authors point to the possibility that in LS cases, in addition to activating the so-called hot zone, other areas such as the frontoparietal are recruited.

## Lucid dreams

In the words of Voss et al.,<sup>12</sup> lucid dreaming is “the experience of achieving conscious awareness of dreaming while still asleep”, or, put another way, a dream is one in which we are able to know that we are dreaming, and even to control certain aspects, while we dream. It is not difficult to imagine the potential that this could have, from a purely recreational aspect to the therapeutic field.

According to Voss et al.,<sup>13</sup> the percentage of subjects who reported having experienced SL at some time in their lives was approximately 50%, of whom again 50% reported having this type of dream at least once a month, being considered frequent dreamers. The frequency of SL begins to decline after the age of 16, and the ability to change aspects of sleep also seems to be less after the age of 14. The theory argued by the authors in that same work to explain this phenomenon has been called the theory of sleep maturation, which alludes to the fact that SLs are an epiphenomenon that occurs naturally, due to the brain maturation process. At this age, high-order mental skills begin to be acquired, such as executive functions, and these are associated with the production of gamma waves. At this stage of life, the brain would be producing gamma waves in a somewhat uncontrolled way, that is, not only when needed (while we are awake) but also by mistake, while we are sleeping. If this activation occurs in the NREM phase, they believe that it would normally cause an awakening, while if it occurs in the REM phase, it is when a lucid dream would occur. In a developing brain, there would be more of these errors, which would explain the greater frequency of SL in adolescents.

In addition to frequency, another interesting aspect is the control of dream events at will. A subject can be aware of being dreaming, but only able to observe what happens as a mere spectator, however, on other occasions it happens that we manage the plot, as happens with the well-known example of flying. Regarding this, we know from works such as that of Stumbrys, Erlacher, Johnson, and Schredl<sup>14</sup> that the frequency of SL and greater sleep control are associated, with approximately 25% of the population being frequent dreamers with control capacity, according to Fingerling.<sup>15</sup> In order to increase this frequency, different techniques have been developed.

### Studies on training in lucid dreams

There is a high consensus on the possibility of training the SL. One of the best known works, for being a pioneer in proposing the MILD technique (Mnemonic Induction of Lucid Dreams, MILD) developed by himself, is that of LaBerge.<sup>16</sup> This is a case study in which the author carried out the experiment himself, reporting an increase in dreams, which started with a frequency of less than one per month and went up to four in one night, supposedly thanks to the MILD technique.

Gackenbach and LaBerge<sup>17</sup> carry out an evaluation of the available data on the characteristics that lead to promoting SL. One of the conclusions is that waking up in an advanced stage of sleep, performing a task that forces wakefulness, and going back to sleep is a productive strategy. This may be due to the increase in the REM phase as the night progresses,<sup>18</sup> since the stimulation threshold necessary to obtain a lucid dream may be narrower in this phase, even more so with the inertia of brief wakefulness activation.<sup>17</sup> Other types of techniques were classified by himself, and are the following:

**One:** training in lucid awareness or reflection technique.<sup>19</sup> consists of asking the question am I dreaming or not? Frequently (5-10 times a day), especially on occasions that may seem like dreams, and just before falling asleep. Not only do you have to think about that sentence, but you also have to reflect on that possibility, maintaining a critical attitude towards the criteria that determine whether what has happened previously makes sense in the real world or not.

**Two:** intention and suggestion techniques. The subject must mentally associate an action with the dream state. For example, "if I look at my hands, I'm dreaming." The problem with this technique is that the subject must remember to do that behavior in the dream (something that would already indicate a degree of will), and then recognize

that behavior to become aware of the dream. Therefore, you need to execute an ability that is the same one that we are supposedly trying to evoke. To solve this, LaBerge<sup>16</sup> proposes the following steps, which constituted his MILD technique:

- 1) During the early morning, the subject awakens spontaneously from a dream.
- 2) After rehearsing sleep, the subject engages in 10 to 15 minutes of reading or other activity that requires full wakefulness.
- 3) Then, while lying in bed and going back to sleep, the subject says to himself: "The next time I'm dreaming I want to remember that I'm dreaming."
- 4) The subject visualizes his body asleep in bed, with rapid eye movements indicating that he is dreaming. At the same time, he sees himself in the dream just rehearsing and realizing that he is dreaming.
- 5) The subject repeats steps 3 and 4 until they feel their intention is clearly set.<sup>16</sup>

Three: pointing techniques such as REM Reminder. These techniques include some kind of sensory cue (haptic, auditory, or light) dispensed in the REM phase. These signals are usually incorporated into the dream<sup>20</sup> which would remind the subject, due to the previous signal-test association, that they must carry out said reality test. These techniques are difficult to calibrate, as the balance between REM sleep and awakening is delicate, and overstimulation may cause sleep cessation, just as understimulation may go undetected. However, it is a useful technique in the laboratory.<sup>20</sup>

Four: Wake Back To Bed (WBTB). This technique, to which we have already alluded, receives those initials from the English translation of getting up and going back to bed. It was proposed by LaBerge,<sup>21</sup> after observing that when he got up in the morning, if he stayed awake for a moderate amount of time and went back to bed to take a nap, the phenomenon was much more likely to appear. Stumbrys, Erlacher, Schädlich and Schredl<sup>22</sup> carried out a systematic review of 35 articles, which shows that the most effective way is to get up between 30-120 minutes before the usual time, wait awake 30-120 minutes, and go again. to bed to take a nap. This strategy is often used in combination with the MILD technique (described above), practicing it when you go back to bed, just before going to sleep.

In addition to these techniques, there are studies that use some other methods that do not fit this description, such as the use of substances such as galantamine,<sup>23</sup> or brain stimulation through currents in the gamma frequency.<sup>24</sup>

### Lucid dreaming and creativity

Another way to approach the knowledge about how or what causes us to have SL is to investigate the characteristics of dreamers. The search for a fully effective method to induce SL is still ongoing, but in the meantime, the characteristics of these dreamers are also being analysed. One of them is creativity, which was studied in a sample of 334 people, giving as a result that lucid dreamers were more likely to incorporate daily events into their dreams, and that these had greater personal relevance, also yielding a higher score in creative personality.<sup>25,26</sup> in a sample of 1,080 subjects who completed an online survey about SL, they were asked about any creative dreams they had (for example, how often dreams have given them creative ideas), also completing a scale of creativity and other personality factors. The results show that 8% of their dreams were a productive source of ideas, in fields such as art, problem solving, emotional issues or

motivators in some way. They also report the direct effect of dream recall rate and thin mental limits on the frequency of these, in line with most studies on the subject. It is also worth mentioning that there is a good number of impact studies on the ability to sensitize a subject during sleep so that when they wake up they perform better on the sensitized task. For example,<sup>27</sup> they trained the experimental subjects to play two different melodies at the same time, through visual cues. Once asleep, only one of the melodies was played during sleep and a performance test was done on the task as they woke up. The conclusion they reached is that the melody that was sensitized during sleep is reproduced more efficiently than the non-sensitized one. Other similar experiments have been carried out, investigating the effect on the ability to remember the association of words and sounds,<sup>28</sup> places where objects and sounds were located,<sup>29</sup> or in visuo-haptic tasks associated with an odor<sup>30</sup> where frontal delta waves are reported when this odor is presented while sleeping, which are the same waves associated with the SL. Finally, this research paradigm has also produced articles on the ability to enhance creativity, presenting subjects with a task that required solutions associated with a smell, as is the case of the work by Ritter, Strick, Bos, Van Baaren and Dijksterhuis.<sup>31</sup> In this experiment, after working with a creative performance task while presenting an odor, the control group was asked, before going to sleep, to open an envelope with a piece of gauze that contained another odor than the one in the learning phase. While the experimental group was offered one with the same odor as the partner during the task. Upon awakening, the performance in this task was measured, finding a better performance in the experimental group. Therefore, One hypothesis could be that SLs can improve the performance of evoked tasks during their production, in the same way that other stimuli do. Of special interest would be to investigate the production of creative solutions, a field that is increasingly productive, although relatively young.

## Creativity

The study of creativity has been a swampy terrain where psychology has found it difficult to get involved. As Santos (1986) pointed out, it was not until the 1950s when scientific production began to explore this topic. He is one of the presidents of the APA (American Psychological Association) who draws attention to the community through a speech delivered the day he took office. Since then there has been a great increase in interest in creativity, expressed through the growth in the number of publications.<sup>32</sup>

The first problem arises, as with the dream, when trying to define what creativity is. The standard definition must contemplate two criteria: originality and effectiveness.<sup>33</sup> But, as this may not be enough to understand what we are talking about, we are going to borrow the words of Stein,<sup>34</sup> about the characteristics of a creative production:

Creative work is novel work that is accepted as sustainable, useful, or fulfilling by a group at some point in time. (...) By "novel" I mean that the creative product did not previously exist in precisely the same form. It arises from a reintegration of already existing materials or knowledge, but when it is complete it contains elements that are new. The extent to which a job is novel depends on the extent to which it deviates from the traditional or status quo. This may well depend on the nature of the problem being attacked, the fund of knowledge or experience that exists in the field at the time, and the characteristics of the creative individual and those individuals with whom he is communicating.<sup>34</sup>

Therefore, we will understand that creativity refers to the ability to generate new (original) and sustainable, useful or satisfactory productions that arise from the recombination of something pre-

existing, obtaining a new product whose characteristics the previous one lacked. It also involves the bulk of experts in the field who are in that context, since this production must be recognized by them as creative, which, in part, depends on the state of the question at that moment.

Simonton,<sup>35</sup> in an attempt to operationalize creativity, are based on the criteria used by the United States Patent Office to propose a formula. This is stated as (C)reativity = (N)ovelty x (U)tility x (S)urprise. The elements, they say, should have a multiplicative and not additive effect, since, if they were simply added, it could be the case that something not at all new, but very useful and surprising, could be considered creative. Therefore, under this formula, it would be essential not to score a zero in any of the categories to consider a production as creative. Gajda, Karwowski, and Beghetto<sup>36</sup> believe that this equation should be represented as (C)reativity = (O)riginality x (TC), where the last variable refers to task constraints.

Such an operationalized definition would be a very powerful tool to be able to measure creative performance, something of special interest in the educational field, in that it is possible to understand a relationship between both processes,<sup>37</sup> which is effective in the repercussion that has one (creativity) over the other (academic performance).

## Creative performance

The evidence on this issue has been, on some occasions, contradictory, sometimes finding null, negative or simply low correlations between both variables. This is the case of Naderi, Abdullah, Aizan, Sharir and Kumar,<sup>38</sup> who with a sample of 153 subjects finds the variables of creativity, gender and age, with little predictive value due to their slight association. However, to shed light on this issue, Gajda et al.,<sup>35</sup> carry out a meta-analysis that includes 120 studies, finding a correlation between creativity and academic performance, this correlation being stronger when the performance measures were carried out through standardized tests and not using school grades. An increase in the correlation is also contemplated when the evaluation of creativity was carried out through tests instead of collecting data through self-reports.

This is consistent with the data obtained by Ai,<sup>39</sup> in the Spanish population. The author affirms that creativity correlates differently according to gender and subjects, with different factors. Specifically, in boys, the flexibility trait seems to be related to all the subjects evaluated (Spanish Language, Basque Language, English, Natural and Social Sciences, and Mathematics), while in girls, the elaboration factor correlates with those subjects of letters, and fluency is done with Mathematics and Natural Sciences. Furthermore, looking at the aggregate data, she also finds an overall positive correlation between academic achievement and creativity.

So, taking into account that creative students get better grades, the next question would be whether it can be trained in some way. Responding to this, we will say that the design of programs or strategies to encourage creativity is new. In the meta-analysis of 34 articles prepared by Ma,<sup>40</sup> in addition to being able to observe the great variety of these programs, it is concluded that creativity can be trained, finding a significantly high mean effect size (0.77). In addition, in the same report, and supporting the objective of this work, they also find that training is more effective in high school students than in university students.

Consensus on this therefore appears to be high. As an example of this consensus, it seems relevant to refer to the declarations of the former president of the APA, as a valid authority, who has also

expressed himself on this aspect, through an article in which he expresses without a doubt that the existence of this relationship and the predictive power of creativity on academic performance are a fact.<sup>41</sup>

### Methods to promote creativity at school

So, if it is related to better academic results, why not boost it from school? The answer is that this is already being done using methodologies such as PBL. If we take into account the most common characteristics of this methodology, it is not surprising to find that there is a large amount of literature that supports the adjustment of ABP in programs that aim to enhance creative performance. In fact, it is in scientific fields, where a certain degree of innovation perspective is required, where there are more studies. Hasni et al.,<sup>42</sup> in a systematic review that selected 48 articles between 2000 and 2014, found that these tended to deal with the application of PBL in areas such as science and technology, biology, physics, chemistry, geology, technology, astronomy, mathematics and other minorities. Besides, It is evident that its use in the so-called STEM fields (science, technology, engineering and mathematics) is very common, since it is a methodology that allows the integration of all these disciplines, allowing the creation of synergies that have an impact on the better performance of students, especially those who normally have lower performance.<sup>43</sup> PBL, in fact, not only achieves better academic results,<sup>44</sup> but also better attitudes towards these subjects.<sup>45</sup> allowing the creation of synergies that have an impact on the best performance of the students, especially those who normally have a lower performance.<sup>43</sup> PBL, in fact, not only achieves better academic results,<sup>43</sup> but also better attitudes towards these subjects.<sup>45</sup> allowing the creation of synergies that have an impact on the best performance of the students, especially those who normally have a lower performance.<sup>43</sup> PBL, in fact, not only achieves better academic results,<sup>44</sup> but also better attitudes towards these subjects.<sup>45</sup>

On the other hand, we also found a large number of works that endorse PBL as a methodology to enhance creative performance. For example, Zhou, Kolmos and Nielsen,<sup>46</sup> found improvements in the motivation of an engineering education creative work group; Karademir<sup>47</sup> conducted an experiment with 13 gifted children, concluding that they had improved their performance in terms of scientific creativity, and Zhou,<sup>48</sup> in just five days, saw results among engineering students. But what does it consist of?

### PBL methodology

The PBL is a method considered active that, according to Thomas,<sup>49</sup> after analyzing ten years of research on this methodology, would be defined as being based on real and challenging problems, in which the student takes an autonomous role, although advised, to carry out medium-long term complex tasks, which differentiates it in the amount of time required from other similar active methodologies, such as Activity-Based Learning.<sup>50</sup> To do this, students must develop some skills that could be the same that adults would use to achieve that production. They must also be involved in the design of the activity, in the investigation, and in the resolution of problems through cooperative learning, to finish the project by presenting the final product. In short, the project should challenge students to solve a real problem autonomously, and present the results. Kokotsaki, Menzies and Wiggins,<sup>51</sup> would reach a similar conclusion, listing three principles on which this methodology is based: learning must be specifically within the context of the learner, the role of students in the teaching-learning process is active, and it is necessary to socially share the knowledge that is being acquired to achieve the goal. In that same work, he would also draw the line that differentiates this

methodology from that of Problem-Based Learning, pointing out that in this the focus of attention is on the learning process, being the collateral final product, while in the one based on projects it revolves around presenting the final product, learning being incidental.

### Brief historical tour

Regarding its beginnings, there is speculation about the origin of the term project, considering the possibility that its beginnings emerged at the end of the 16th century, through the work of European schools of architecture, to later make the leap to America and become in an established method of teaching in public schools.<sup>52</sup> The next steps would be taken around 1865, hand in hand with the educational theories on pragmatism, experiential learning and progressive (or, rather, progressive) pedagogy proposed by John Dewey, who conveyed the need for students to socialize in the school, as a replica of real life, carrying out life learning, not theoretical or symbolic, but fully integrated with their future after school, giving complete continuity to this process.<sup>53</sup> The method was spreading, being applied to manual labor training, science, and also agricultural education.<sup>54</sup> This aroused the interest of a student of Dewey, who baptized the idea at this time as The Project Method.<sup>55</sup> This idea was here to stay and, in part, it was also thanks to the work of Francis W. Parker,<sup>56</sup> who contributed to its dissemination with several practical works.

However, Kilpatrick's first steps were rocky, failing in some projects in America, and being criticized by Dewey. He himself would admit his mistake, pointing out that he should not have taken it as a subjective philosophy, but as an objective method.<sup>54</sup>

This project died of success, being adopted by many professionals, but in a lax way. Any activity based on the student's interest in the task was justified as PBL. Therefore, we could locate the beginning of this methodology with Kilpatrick, who had become a recognized eminence, being invited to countless conferences.

Other similar methodologies, such as Problem-Based Learning, much confused with project-based learning, emerged in the last decades of the 20th century as a form of teaching. In this case, it is the McMaster Medical School in Canada the one that houses the new concept.<sup>56</sup> Although similar in the active part of the student, making him the center of the class, the background of the problem-based methodology is not to integrate life in school, but to learn in a practical way. And it is that, this is born from an educational response to the problem of seeing how many of the students with a high degree of knowledge in their professions, do not know how to apply it in a practical way. However, it does not claim to have the humanistic value implicit in project-based learning.<sup>57-60</sup>

PBL has been appearing and disappearing to this day as a function of the educational crises that have arisen, increasing interest in the last 15 years, but with the same definition problem that brought down Kilpatrick's The Project Method. However, today, as we have seen, we believe that it makes more sense than ever.<sup>61-67</sup>

After the analysis of the available literature, we have achieved the first general objective of our work, see carry out a bibliographic review to find out if research on SL through the PBL methodology could increase the creative performance of students.<sup>68-75</sup> With this, we conclude that an intervention of these characteristics has support in the specialized literature on each of its components, being applicable (SL can be trained), relevant (research in this field with an adolescent population is needed and could influence the creative performance and the competencies that we hope to increase in students will be needed in the future), it is well-founded (there is specialized literature that supports the relationship between ABP and SL with creativity),

it is coherent (all elements can be consistently related) and original (there is no research on the subject with this population.<sup>76–87</sup>)

## Conclusion

The social and technological future that awaits us will require properly human qualities. The most mechanical professions, which do not require creativity, initiative and innovation, are the most likely to disappear. It is because of them that, as teachers, we have the obligation to train students who develop the skills of tomorrow's jobs. For this, and as recommended in current educational regulations, methodologies such as APB must be used, giving students autonomy. This methodology has been shown to be suitable for promoting creativity and the development of the aforementioned qualities, since it implies that the students are the ones who get involved in the project and take control of it, having to develop problem-solving skills. Besides, this type of project must be real and not figurative, contextualized and significant. That is why including them in the process and design of a research project will be appropriate, as long as it is real. This is the case of research in SL, a field under exploration that is already being used to improve certain abilities, but that has been little explored with the adolescent population. Research in SL has shown that these can be trained and that they are directly related to the creativity of dreamers, but that has been little explored with the adolescent population. Research in SL has shown that these can be trained and that they are directly related to the creativity of dreamers. But that has been little explored with the adolescent population. Research in SL has shown that these can be trained and that they are directly related to the creativity of dreamers.

For all this, considering the main objectives that we have proposed at the beginning of our work, we believe that the first of them, which consisted of collecting evidence within the literature on creativity, SL and ABP that justifies that the project is theoretically applicable, relevant, grounded, coherent and original, has been achieved. It has been verified that the innovation project is applicable (SL can be trained and is adjusted to educational needs), relevant (research in this field with an adolescent population is needed and could influence creative performance and the acquisition of skills) related that we hope to increase in students, since they will be needed in the future), it is well-founded (there is specialized and reliable literature that supports the relationship between ABP and SL with creativity).

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## Conflicts of interest

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