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Empowering Environmental Education in Portuguese Primary Schools:
Energy Focused Curriculum Recommendations and Behavioral Change Framework
Guided by Principles of Developmental Psychology

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Independent Study Project
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Abstract

This paper explores the integration of principles of developmental psychology within the context of environmental education in Portugal to promote pro-environmental behavior, and specifically energy literacy energy conservation behaviors in primary school students. A review of current literature on the state of environmental education approaches in Portugal exhibits a significant lack of structure and direction for educators to teach students relevant topics in sustainability. Using a meta-theory of behavioral change, the present work connects the elements of the COM-B model of behavioral change to relevant aspects of middle childhood cognitive development using principles of two major theories of developmental psychology. As children today are certainly developing into the change-makers of tomorrow, middle childhood presents a critical and influential time of learning. By placing the present work in the context of existing curricula covering topics in environmental education for primary school, topics on energy and energy conservation are limited. The findings of the thematic literature review in conjunction with an interview with a current primary school educator in Lisbon, Portugal support the creation of an updated version of the COM-B model of behavioral change. The updated model, drawing from the findings of the present work, aligns elements from themes identified in the literature review with ideas from two developmental psychology theories to create suggestions and recommendations for teaching and implementing energy-specific curricula. While the present work merely touches on all that can be explored and assessed within the parallels drawn between these two disciplines, it begins an important conversation on the relevancy and need for curricular modifications in environmental education on energy.

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1. Introduction

1.1 Children as the Future of Change

       In the ever-evolving narrative of global advancement, today's children are not merely bystanders, they are those who are preparing to steer where humanity is heading next. When considering the time in childhood development, both cognitive and physical, when some of the biggest transitions occur, literature turns to middle childhood. The time of middle childhood is especially impactful for a diversity of reasons. However, it is particularly important to acknowledge that no type of development occurs in a vacuum, and is always impacted by a variety of factors (Glowiak & Mayfield, 2016). This developmental stage begins laying the foundational learning groundwork to set them up for success across future various academic experiences.

       For many children, this is their first exposure to a formal academic environment where they begin acquiring the foundations of literacy, numeracy, and cognitive skills which are skills they will use for the rest of their lives (Blake & Pope, 2008). During this developmental stage, a child's brain exhibits a unique and temporary plasticity, making it the optimal time for learning and acquiring new understandings (Mah & Ford-Jones, 2012). This highlights the critical importance of childhood education at this age. Additionally, this time brings a significant increase in socialization and interaction with parents, teachers, and peers alike helping to support and shape their communication skills and their understanding of social norms (Arnett & Jensen, 2018). In turn, frequently these growing relationships, understandings, and experiences lead to lasting formations of beliefs and values about the world and the way it functions.

       At this developmental stage, children are highly influenced by the role models around them, including parents, teachers, siblings, and other adult figures. Both positive and negative experiences with these role models can shape children's attitudes and behaviors. These influences ultimately impact their future achievements, personal growth, and sense of social responsibility. Middle childhood also presents a time of seemingly never-ending curiosity and exploration. Children at this stage are motivated to ask questions, seek answers, and better understand the world around them through hands-on experiences and experimentation. Taking all of these aspects of a basic understanding of what cognitive developments occur in middle childhood helps to understand why this age is critical in creating lasting perspectives, knowledge, and behaviors. This stage in development presents a window of opportunity for intervention promoting positive behaviors, knowledge, and beliefs. The present work will focus on how these developmental cornerstones can help support environmental education efforts to encourage pro-environmental behaviors (Osbaldiston & Schott, 2011) in the future.

       As many researchers have identified, there lies great importance in properly and thoroughly educating the children of today on such critical aspects of environmental sustainability as they will most likely be those most responsible for addressing and creating actionable solutions to the effects of climate change (The Global Goals, 2023, Target 4.7). Although environmental education is a globally recognized priority as a part of the Sustainable Development Goals (Ojala, 2019), these environmental education initiatives rarely acknowledge the importance of understanding the cognitive and social development status of those who are being taught and the role cognitive development plays in the grand scheme of creating tomorrow's leaders and today's agents of change in global sustainability (Walker, 2016). If children are poised as the future of change, educational curriculums teaching and encouraging sustainable behaviors, attitudes, and knowledge must be tailored to how these individuals learn,

process information, and interact with their environment. This will support the accessibility of environmental sustainability topics and encourage further and lasting engagement.

Today, environmental education stands as a critical aspect of any educational experience because it plays a critical role in promoting sustainable development and environmental sustainability by providing individuals with the knowledge and skills to make informed and sustainable decisions across areas of their lives (Uralovich et al., 2023). Literature reveals that there are numerous environmental education programs designed for students in primary school across the globe (Suarez-Lopez et al., 2022), but not all can be created equal. Environmental education programs for children in early and middle childhood often prioritize simpler topics like recycling and composting for students of a certain age, assuming that more complex subjects like energy are too difficult for them to grasp (Duhn, 2012). However, it's crucial to recognize that while the details may be intricate, there's potential to convey basic concepts such as the importance of energy consumption, its sources, its impact on climate change, and basic political contexts. By aligning these ideas with the cognitive abilities of children, we can foster lifelong learning and ensure they grasp essential environmental sustainability principles early on, preventing possible misconceptions and lack of pro-environmental behaviors from forming later in life.

1.2 Importance of Energy Literacy

Broadly speaking, energy literacy can be defined as a concept that encompasses one's knowledge of basic energy-related topics, an understanding of how energy production and consumption impact the environment, the understanding of the various ways energy is used in day-to-day living, and the active adoption of energy saving and sustainable behaviors (Martins et al., 2020a). Because of this, three primary components of energy literacy have been identified as guiding principles for a better understanding of how energy literacy occurs and can be improved. Knowledge, attitude, and behavior constitute these guiding dimensions. While initially energy literacy was understood to be a way to discuss only an individual's knowledge of energy and energy use, literature has proven that energy literacy is a far more comprehensive notion (Martins et al., 2020b). There have been numerous findings across the literature on energy literacy concluding that energy literacy levels across the globe remain low despite a growing understanding of the role of energy production and consumption as a contributor to climate change. Some literature has gone as far as claiming that many individuals continue to operate under the belief that energy and environmental issues are far from areas of concern today (Yuksel, 2019). This could not be further from the truth.

While there is evidence that attitudes toward supporting sustainable energy practices, the disconnect lies in the knowledge component, which in turn decreases the likelihood of corresponding behaviors to attitude (Martins et al., 2020b). This helps to inform the critical nature of the implementation of focused energy literacy programs within the broader domain of environmental education to develop energy literacy behaviors for future generations who will soon be guiding the directions of environmental sustainability initiatives towards a sustainable future. The incorporation of energy literacy concepts, specifically within a primary school setting, plays a vital role in the broader discussion of environmental education by shaping energy-conscious behaviors tailored to the characteristics of the target students. As previously mentioned, at this developmental stage students experience cognitive development, allowing them to progressively cultivate logical and scientific thinking skills applicable to understanding more complex topics over time (Rohmatulloh et al., 2023). By encouraging positive

environmental attitudes during this formative period, such initiatives lay the foundation for lifelong habits of responsible energy consumption (Martins et al., 2020b). The primary focus of the following research paper will focus specifically on education on energy in Portugal to support the ever-growing need for a climate-literate society.

1.3 Justification for Focusing on Energy and Energy Literacy in Portugal

There has been a global shift towards the realization of the role that energy consumption plays in global warming processes and climate change. The European Union (EU) has set ambitious yet extremely applicable goals concerning energy use and consumption of its member states. For example, in 2014 the EU adopted Energy and Climate targets for 2030 which include targets such as a 40% reduction in greenhouse gas emissions compared to 1990 levels and at least 27% improvement in energy efficiency (Bertoldi & Mosconi, 2020). The disconnect resides in the political sphere, especially in the Southern European countries. Portugal in particular, despite the EU-spanning efforts towards sustainable energy consumption, has a significant problem with access to residential properties with high energy efficiency certificates in comparison to Scandinavian countries (Fuinhas et al., 2022). Portugal struggles with a severe energy poverty issue based upon low-income levels for residents and the lack of access to energy-efficient technologies. Fuinhas et al. (2022) discuss further that the household sector consumed 18.2% of total energy consumption in 2019, but the struggle with energy poverty along with the inefficiency of public policies related to energy management and consumption have only exacerbated the energy poverty endemic.

Comparisons have been drawn between Northern and Southern European countries in reference to the energy transition to the consumption of more renewable energy sources and while countries such as Sweden, Denmark, Iceland, and Norway are rapidly increasing their presence of renewable energy sources, Portugal and other Southern European countries are experiencing far more challenge (Magazzino et al., 2022). Portugal and other Southern European countries alike, with different economic, cultural, and climatic characteristics in comparison to the Northern countries (Fuinhas et al., 2022), require their own set of energy consumption insights and next steps to align with the overall EU guidelines. When it comes to education on energy, these initiatives should not only educate on individual behaviors and actions that each person has a responsibility to uphold when it comes to responsible energy consumption, but it should also include education on the importance of collective political engagement and the importance of careers within the renewable energy sector (Jorgenson et al., 2019). This only further solidifies the importance of including appropriate and effective environmental education practices, specifically on energy in Portugal.

1.4 The Present Study

Current literature on environmental education initiatives and programs, although becoming increasingly prevalent, lacks specific curricula aimed at supporting the education of children on the importance of responsible and sustainable energy behaviors both at an individual and societal level. By focusing on the specific ages within the first cycle of basic education in Portugal, the present work explores the unity between the fields of environmental education, environmental policy, and developmental psychology to promote energy literacy and pro-environmental behavior. This work situates itself between two distinct discourses when it comes to energy consumption and sustainability. The first is that energy has been, and will remain a vital force in the continuation of human development and advancement (Barreto et al.,

2023). On the other hand, burning fossil fuels for energy creation is the largest contributor to climate change and its corresponding effects (Jorgenson et al., 2019). One pressing recommendation from the 2018 Intergovernmental Panel for Climate Change (IPCC) was the need to dramatically alter energy consumption and systems around the world to stay below 1.5 degrees Celsius global warming (IPCC, 2018).

With this in mind, the education of the future generations who will continue the work that has already begun is extremely critical to ensure lasting success and longevity of sustainability initiatives as they are known today. Structured using a behavioral change framework in conjunction with theoretical frameworks of developmental psychology, the present study will utilize an interdisciplinary dialogue to conclude with recommendations for teachers, parents, and educational policymakers. These recommendations will be a result of investigating how the integration of principles of developmental psychology can enhance environmental education within the basic education curriculum in Portugal. In the next sections of the paper, a thematic literature review will help to provide relevant background information on the context of education in sustainable development, the current approaches to environmental education in Portugal, and summarized descriptions and relevant applications of two key theories of developmental psychology. In addition to the descriptions of said psychological theories, the literature review will cover the basics of the COMB-B model of behavioral change that identifies key dimensions for promoting sustainable behavior change and to help inform the analysis. The results and discussion will consist of an updated version of the COM-B model specifically curated by the topics explored throughout this paper. There is hope that the findings of this paper will help to support effective and lasting approaches to environmental education in Portugal.

1.5 Research Question

How can the integration of principles of developmental psychology enhance environmental education within the basic education curriculum in Portugal?

2. Materials and Methodology

Through in-depth research on existing literature covering environmental education, theories of developmental psychology, and the current state of environmental education in Portugal, this project aims to identify how principles of developmental psychology can align with dimensions of capability, opportunity, and motivation in behavioral change. Specifically facilitating energy conservation behaviors in Portuguese primary school students. The focus is on teaching environmental education with a specific emphasis on energy topics in Portugal. The goal is to explore how insights from developmental psychology can inform the design and implementation of educational programs that resonate with the cognitive, social, and emotional development of students. The present work presents a conceptual paper based on a literature review covering environmental education and education for sustainable development and an interview with a current educator in Portugal. This leads to an integration exercise taking models from psychology and behavioral psychology to better support education recommendations on energy. These methods help to synthesize and combine concepts between two distinct disciplines to help inform one another. This is something that has yet to be done at such an in-depth level.

The utilization of a meta-theory of behavioral change allows the present work to systemize insights from developmental psychology that support environmental education programs on energy. This paper works to connect the elements of the COM-B model of behavioral change to relevant aspects of childhood cognitive development using principles of a

chosen few major theories of developmental psychology. Two theories of developmental psychology were chosen for their interdisciplinary application nature and relatively well-known status within the realm of psychology. A focus on primary school-aged children (aged six through ten) narrows the project's psychological center point and creates space for more curated recommendations. This will allow for the creation of a set of recommendations aimed at supporting educators, curriculum development, educational policies, and parents in furthering the efficacy of environmental education through an interdisciplinary lens.

Academic sources and references were gathered through search engines including Google Scholar, PsycINFO, and the University of Puget Sound library database (the University of Puget Sound is the home institution of the author). References were gathered and organized by the author using a literature review matrix to ensure relevant sources were included for all topics covered throughout the project. Following ample amounts of reading and analyzing of the literature, a narrative analysis was used to organize and analyze the findings within the context of the present work. Included within this literature review were sources that supported the structuring of the paper using the COM-B model. This helped to further understand how to apply the theory to the question at hand.

The research process for this project also included one interview over the phone with a current primary school-level educator teaching in Lisbon whose insights helped to inform much of the conversation within this paper on the current state of environmental education in Portugal. The author asked questions regarding her teaching experience, what her experience is in teaching topics in environmental education, whether she has taught any curriculum specific to energy, and her perspective and insight into how environmental education curricula could be improved. These questions were used as guiding talking points, but the interview took a very conversational approach. She provided ample information on her experience teaching topics in environmental education and supplied curriculum programming resources related to environmental education in Portugal (Table 1). This information is sourced from the Ministry of Education of Portugal and has been adapted to highlight aspects of the curriculum most applicable to the present work. A thematic literature review in conjunction with the COM-B theory of behavioral change supports the identification of themes and connections across the disciplines. The present work will draw from existing curriculum guidelines for teaching environmental education topics to develop modifications and suggestions based on conclusions. This will lead to the creation of an updated version of the COM-B model including connections to developmental psychology and recommendations specific to environmental education with a focus on energy.

2.1 Limitations

The present work lies in a very theoretical realm lending itself to an exploration that is constantly shifting and evolving. The author acknowledges that there were many areas throughout the paper where decisions had to be made regarding the appropriate level and amount of content to include. Due to the limited timeline and available resources, and the extremely expansive nature of the topic, the present work only scratches the surface of what is to be explored within the bounds of the interplay between effective environmental education and the role of cognitive development in learners. Furthermore, this paper was only able to consider two of the primary theories within the discipline of developmental psychology. This decision was made in light of both the project timeline as well as to not overwhelm the contents and argument of the paper. As mentioned above, the present study acknowledges the great limitations that only drawing from these dated theories of developmental psychology leads to in the present argument.

Regarding the literature review, there is always more literature available to draw from than is possible to include in this work. Not all relevant literature was able to be included. Additionally, the author acknowledges the conscious decision to generalize students within the ages of primary education into the distinct stages and categories highlighted by the theories of developmental psychology. To not add too many extraneous variables to the paper's argument, the decision was made to exclude outliers. The author acknowledges the inevitable nature of outliers in development as development is different in one way or another for every individual. This factor could be expanded upon if future work on the subject is pursued. In addition, the present work was limited by the number of educator interviews that were able to be performed in the time allotted. It would be extremely interesting for future work to draw from a variety of interviews with Portuguese educators. This would support a greater reliability of the study's methodology. The final decision to perform only one interview with a current Portuguese primary school educator was a result of limited time and limitations when it came to communicating and developing several relationships with individuals in the time allotted for the project. Finally, the author acknowledges that while the COM-B model of behavior change was the chosen framework to organize the present findings, this may not be the most suitable. Future research could take a similar approach but see if there are any significantly different conclusions if an alternate theory of behavioral change is used.

2.2 Ethics

The present research used primarily secondary data sources and one interview providing relevant and applicable insights for the project's context. For the interview, all ethics protocols were followed and the participant was informed of the project's aim and how their responses would be utilized. The interviewee provided verbal and written consent for her responses to be used in the present work, but all identifying attributes have been omitted to protect the participant's confidentiality. This project takes responsibility for responsibly referencing the work and findings of all authors referenced throughout the paper and in the References section.

3. Literature Review

3.1 United Nations Decade for Sustainable Development

In 2005, the United Nations (UN) launched the Decade of Education for Sustainable Development (DESD). This undertaking was focused on promoting the integration of principles and practices of sustainable development into education at all levels across all member states (United Nations Educational, Scientific and Cultural Organization, 2014). The final Global Monitoring and Evaluation Report produced by the UN in 2014 was able to identify both successes and challenges encountered during the decade. Most notably, the report stated that DESD was able to shape a broader and deeper understanding of the importance of having a knowledgeable workforce that will help contribute to the development of a greener future. This has led to an increased investment in educational efforts for the advancement of sustainable development at an international level.

Although these trends hold true today, there are still many global challenges preventing a universal adoption of said ideologies and practices highlighted in the DESD. Challenges in particular lie in the continued need for more alignment between the education and the sustainable development sector due to a lack of inter-ministerial cooperation (United Nations Educational, Scientific and Cultural Organization, 2014). Additionally, many member states have yet to reach

a standardized implementation of education for sustainable development. This is primarily where Portugal is experiencing the majority of its challenges when it comes to the implementation of environmental education across all levels of education. In a 2018 research article, Farinha et al. (2018) explored the integration of sustainability education into the policies and strategies of higher education institutions (HEIs) in Portugal. Their work focused particularly on the framework of the DESD and found an overall need for a centralized system for education for sustainable development (ESD) implementation in Portugal. While the Ministry of Education has acknowledged the importance of sustainability education (João et al., 2022), there is a lack of uniformity across HEIs and disciplines. This has led to a very fragmented and inconsistent educational approach when it comes to Sustainability Education topics. Although the work of Farinha et al. (2008) was focused on ESD within HEIs, the trend of the lack of a solidified system for ESD in educational curricula within Portugal can be seen across educational levels.

3.2 Environmental Education and ESD in Portugal

When turning to the state of environmental education and ESD in Portugal in particular, the existing literature is limited but informative. One specific article helps to illuminate trends of environmental education in Portugal throughout history and the issues that remain today. Schmidt et al. (2011) acknowledge that the push for implementing environmental education in Portugal began over 40 years ago following the return to a democratic society. Topics in sustainability were integrated into educational curricula under the support of the European Union including financial support and the provision of additional resources to develop the programming across the country. Despite this positive move towards creating a more educated society on the environment and sustainability, a persisting notion remains. The impacts of these efforts aimed at preparing future citizens to deal effectively with environmental problem-solving are not yet evident.

Literature covering the state of environmental education and ESD in Portugal has been able to conclude with very similar trends and findings. As previously mentioned, a trend prevalent across studies concerning the societal movement toward more sustainable knowledge, attitudes, and behaviors in Portugal lies in the lack of information and knowledge on relevant issues facing the country and the world (Schmidt et al., 2011). Furthermore, research has revealed that while there is evidence of societal concern for the state of the environment and the importance of sustainability practices today, what continues to lack are actions promoting and performing pro-environmental behaviors (Mosca et al., 2024). This exemplifies the crucial role of appropriate and well-rounded educational efforts in teaching sustainable behaviors and ESD and the importance of encouraging personal reflection and involvement at any age.

Another trend is seen throughout current literature on environmental education across Portugal displaying the lack of equality in where and how environmental education programs are mobilized across different schools and institutions. First, a large portion of the current literature covering environmental education within schools in Portugal focuses on the presence or lack thereof, of said topics at a higher education level. Although the present work focuses specifically on the integration of environmental education and ESD within the basic education system in Portugal, these resources provide critical context for a more in-depth exploration. In a 2021 study investigating the climate knowledge of Portuguese adolescents, García-Vinuesa et al. explore how the positivist paradigm of education has remained the dominant view and educational approach to teaching climate literacy. The article acknowledges that climate literacy has been the favored educational approach to tackle climate change as part of science literacy. Despite this

fact, there is ample evidence today that these approaches aimed at looking purely at the scientific aspects behind climate change behavior have proven to be inefficient in the global initiatives toward an educated and equipped population on climate change. With these ideas in mind, García-Vinuesa et al. assessed whether levels of scientific knowledge about climate change might predict beliefs and perceptions about the phenomenon. Assessing levels of climate change knowledge among adolescent students in Portugal revealed that the level of scientific knowledge about climate change does not significantly differ between students specializing in science and technology versus those in social sciences and humanities. Students across specializations showed equal levels of misconceptions and beliefs about climate change only further encouraging a move to a new conceptualization of educational approaches. This is extremely important as it highlights the critical role that the interdisciplinary nature of environmental education has in teaching about the importance of pro-environmental attitudes and behaviors.

The aforementioned topics are relevant to the present discussion for a variety of reasons. Most notably, the need for more universal recognition of the interdisciplinary nature of environmental education and ESD and the importance of teaching topics in environmental education beyond just the science classroom. Because there remains no standardized or universal curriculum in Portugal for environmental education and ESD (Farinha et al., 2008), the approach to teaching such topics varies greatly across locations, schools, and ages. Returning to the insights provided by Schmidt et al. (2011), there remains a persistent need for a more holistic, integrated, and community-engaged approach to environmental and sustainability education in Portugal. These findings imply the importance of taking learning outside of the classroom and engaging the students and those who surround the students. It also enforces the idea that topics included in environmental educational curricula should not only include traditional environmental sustainability topics such as waste management and nature conservation. These educational curricula should include topics in sustainability across social, economic, and ecological dimensions along with more complicated, yet critical, topics such as energy conservation.

When returning to the UN Sustainable Development Goals (SDG) mentioned at the beginning of this paper, Greig and Priddle (2019) develop three dimensions of Target 4.7 to support the contextualization of environmental education and ESD. First, the authors discuss the importance of both students and educators working across and between a variety of academic disciplines. Only when these disciplines are brought together systematically can the complex issue of global sustainability be addressed. Secondly, education on sustainability and ESD must be focused on real-world implications of knowledge and acquiring skills, instead of being focused on factual or practical knowledge about specific subjects or biased 'solutions'. Suárez-López and Eugenio-Gozalbo (2021) touch on this dimension emphasizing the need to recognize the limitations brought about when sufficient solutions to issues of sustainability rely only on science and technology. Rather, sufficient approaches should include an effective and appropriate combination of knowledge acquisition and putting this knowledge into practice (Greig & Priddle, 2019). Finally, Greig and Priddle (2019) reinforce the notion that learners in environmental education are taught and assessed in a way that aligns with the nature of environmental education. This implies a change in teaching and assessment approach within the complex area of sustainability education. Rather than focusing on "assessment of learning" following a learner's acquisition of knowledge from an educator, approaches to environmental education should focus on "assessment for learning" and "assessment as learning". Although these dimensions have been designed within the context of environmental education and ESD at

a higher education level, the principles are entirely relevant when it comes to education for all levels. Therefore, these dimensions help to inform the creation of effective pedagogies for any topic regarding sustainability.

3.3 Insights from an Interview with a Current Portuguese Primary School Educator

Taking all of the previously mentioned topics and principles covered in the existing literature into account, an interview with a current primary school educator in Lisbon, Portugal provided first-hand insight into how environmental education is present within her field (Educator, 2024). She was motivated to become a primary school educator in the first place because she is driven to share her environmental knowledge with her students. During her 20 years as an educator, she has seen many attempts at schoolwide sustainability projects, everything from speakers from the municipality on basic sustainable practices to the application of solar panels on the school's roof. Similar to the notions and findings provided by Greig and Priddle (2019), nearly all of these initiatives have been fleeting and struggle to incorporate more than just the school's students and faculty. Focusing on the solar panels as an example, she stated that following the implementation of the solar panels at the school, at this point, no one has been informed of whether or not the panels are actually providing any energy. She emphasized this as a way to highlight the fact that, despite positive intentions, the state of Portuguese sustainability efforts is still highly unorganized.

Within this same vein of disorganization, this educator reveals how she has taken teaching her students about the environment into her own hands due to the lack of a direct and concrete curriculum for environmental education in Portugal. Throughout her time, she realized that the country's curriculum doesn't provide sufficient time to cover all topics under the environmental education umbrella, so she created her own mixed, or interdisciplinary methodology. One example of this that she touches on throughout the interview is her purposeful usage of the outdoor classroom. She brings her students outside into the forest and supports each of them in their exploration. She helps them to pay attention to the large and small things alike. Her students make observations and then she uses these experiences throughout a variety of the classes she teaches. From prompting art projects to solving math problems based on their observations, she helps to instill the importance of the environment across areas of study. With this work, she is supporting the importance of cultivating an early appreciation for the environment, which in turn has been shown to significantly affect the rate of pro-environmental behaviors of those individuals in the future (Barrable & Booth, 2020; Duhn, 2012). When asked about energy-specific topics, the conversation returned to the notion of the lack of a universal curriculum covering a variety of topics within sustainability. This further reinforced the realization of the lack of topics specific to energy and energy conservation within environmental education specifically in Portugal.

One of the final insights this educator shared was regarding the importance of the role model when it comes to educating children of this age. As a teacher for students ages six through twelve in the first cycle of basic education, she recognizes the significant level of impression she has on her students. Duhn (2012) references the idea of the "culture of fear" that the globe is currently plagued with when it comes to the discussion about the state of the environment. There can also be an argument made that schools and places of education are equally at fault for this culture as parents or guardians as a result of such controlled and political approaches. She references this notion within her own experience touching on how her teaching philosophy has changed over the years. She speaks to her role as an educator and her responsibility to both be

knowledgeable on the subjects in question and also ensure that educators work to never teach hopelessness in environmental education. The students of today are the change-makers of tomorrow. She emphasizes the importance of ensuring that topics in environmental education are not creating a future society of individuals believing that the end of the world is coming. These topics should encourage engagement because what the future needs is not fear, rather it is a society of passionate and educated change-makers that can both think and act.

Throughout the conversation, she referenced one part of her required curriculum in particular called "Estudo do Meio" or "Middle Study". This specific curriculum is mandated by the Direção-Geral da Educação (General Directorate of Education) of Portugal and is curated for students within cycle one of basic education (grades one through four). Named the "Essential Learning of Environmental Study, the primary goal of this curriculum is to support students in the development of a range of skills from different areas of knowledge (Directorate-General for Education, 2018). Acknowledging that topics concerning the environment and environmental sustainability are derived from a variety of different areas of knowledge, this curriculum draws from disciplines such as biology, physics, geography, geology, history, chemistry, and technology. Through this curriculum, students should develop a progressive understanding of society, nature, and technology, as well as the interconnectedness between them. As seen in Table 1, the curriculum guidelines are organized into each of these three areas with the corresponding knowledge to be acquired, and attitudes and skills to be developed. Although this is a large step in the direction of developing a knowledgeable and equipped set of students, the conversation with her reveals the persisting lack of specific pedagogical perspectives and approaches. While Estudo do Maio provides specific targets for each domain and for each age, it lacks specific guidelines for how these targets should be taught and why these targets are important for the student. It also lacks the acknowledgment of the role of the educator and the importance of a solid knowledge basis for both the student and the educator.

3.4 Effective Educational Approaches

Finally, when discussing the previously found effective approaches to teaching environmental education, current literature highlights a select number of approaches most applicable to creating lasting attitudes and behavioral changes. One of the most prevalent themes in literature is the importance of fostering emotional investment in an issue to facilitate lasting behavior change (Schneider & Van der Linden, 2023). This concept of supporting the development of emotional connection with the issue at hand has been proven to be an effective approach to effective education and behavioral change in all ages. Schneider and Van der Linden (2023) speak to the important role of emotions in fostering sustainable behaviors through a "self-reinforcing feedback loop". This feedback loop suggests that positive emotions experienced following the performance of said sustainable behaviors lead to positive anticipatory emotions regarding future engagement in sustainable behaviors. This creates a self-reinforcing positive feedback loop that can be seen as a crucial tool when developing programming for teaching environmental education.

In addition to the emotional component of fostering the development of lasting pro-environmental behaviors, another approach seen across literature speaks to the importance of creating hands-on educational learning opportunities. A 2019 review looking at the importance of integrating a sustainability perspective into the domain of psychology, argued for the significance of real-life experiences and transdisciplinary work in sustainability education (Ojala, 2019). This review touches on two different examples of how experiential learning can be

implemented in the classroom. The first focuses on problem-based learning where students are tasked with solving real-world issues within the area of concern. This allows students to develop and practice critical skills such as collaboration and critical thinking, while the educator fills the role of a facilitator in the learning process. Along similar lines, another example of this practice can be seen by using students' own life experiences regarding the area of concern as a starting point for the learning process. Although this review in particular focused on experiential learning within higher education academics, these principles can be applied and adapted to educational approaches for all ages.

When thinking about the implementation of experiential learning and the application of real-life experiences into education, an area that has been proven to be successful in the display of behavioral change is education on energy and energy conservation. Although not extremely prevalent, one study, in particular, found that facilitating learning through projects based on real-world topics within energy conservation was an extremely effective way to motivate and engage learners (Karpudewan et al., 2015). At its core, project-based learning is known as a model that organizes learning curricula through a series of projects. These projects support student interest and engagement while simultaneously prompting the development of critical skills such as asking questions, decision-making, and discovery. Karpudewan et al. (2015) were able to conclude that high-school students who were instructed using the project-based learning curriculum took more responsibility for their learning compared to students in more traditional educational curricula. Once again, although this study was focused on high-school students, these findings provide valuable insight into the development of future environmental education efforts for students and individuals of all ages.

3.5 Table 1: Estudo do Meio (Middle Study)

Year/Age	Domain	Knowledge, Skills, and Attitude Targets
First Year/6-7	Nature	● Identify risk situations and behaviors for individual and collective health and safety in different contexts – home, street, school, and aquatic environment and propose appropriate protection measures. ● Identify the factors that contribute to physical and psychological, individual and collective well-being, developing daily routines for personal hygiene, food, clothing, and spaces for collective use. ● Recognize the implications of daily atmospheric conditions in your daily life. ● Recognize the importance of the Sun for the existence of life on Earth.
	Technology	● Recognize that technology responds to everyday needs and problems (electricity network, water pipes, telecommunications, etc.). ● Identify human activities that involve technological transformations in the world around you.
	Society,	● Relate spaces in your experience with different functions,

	Nature, Technology	- establishing identity relationships with the space. - Know how to ask questions, raise hypotheses, make inferences, prove results, and communicate, recognizing how knowledge is constructed. - Demonstrate attitudes of respect, solidarity, cooperation, and responsibility in relationships with those who are close to you. - Express positive attitudes leading to the preservation of the immediate environment, being able to present intervention proposals, namely behaviors that target the three "Rs".
Second Year/7-8	Society	- Relate institutions and services that contribute to the well-being of populations with their respective activities and functions. - Recognize the importance of dialogue, negotiation, and compromise in the peaceful resolution of conflict situations.
	Nature	- Reflect on behaviors and attitudes, experienced or observed, that contribute to physical and psychological, individual and collective well-being. - Relate threats to the biodiversity of living beings with the need to develop responsible attitudes towards Nature.
	Technology	Distinguish the advantages and disadvantages of using technological resources (analog and digital) in your daily life.
	Society, Nature, Technology	- Describe the natural and human elements of the place where you live by collecting information from various documentary sources. - Recognize the existence of common goods for humanity (water, air, soil, etc.) and the need for their preservation. - Know how to ask questions about environmental problems existing in the locality where you live, particularly related to water, energy, waste, air, and soil, presenting intervention proposals.
Third Year/8-9	Nature	Understand that living beings depend on each other, particularly through food relationships, and on the physical environment, recognizing the importance of preserving nature.
	Society, Nature, Technology	- Recognize how environmental changes (deforestation, fires, siltation, pollution) cause imbalances in ecosystems and influence the lives of living beings (survival, death, and migration) and society. - Identify an environmental or social problem existing in their

		community (urban solid waste, pollution, poverty, unemployment, social exclusion, etc.), proposing resolution solutions.
Fourth Year/9-10	Nature	• Identify plants and animals that are on the verge of extinction or even extinct, investigating the reasons that led to this situation. • Describe different types of land use in your region (agricultural, forestry, industrial, or tourist areas), comparing them with those in other regions. • Recognize how human activity interferes with the ocean (pollution, changes in coastal areas and rivers, etc.).
	Technology	• Recognize the importance of technological evolution for the evolution of society, relating objects, equipment, and technological solutions with different everyday needs and problems. • Produce technological solutions through the reuse or recycling of materials (weather vane, solar oven, etc.).
	Society, Nature, Technology	• Relate the increase in the world population and the consumption of goods with changes in the quality of the environment (destruction of forests, pollution, depletion of resources, extinction of species, etc.), recognizing the need to adopt individual and collective measures that minimize the negative impact. • Knowing how to ask questions, raise hypotheses, make inferences, prove results, and know how to communicate them, recognizing how knowledge is constructed.

Table 1. Adapted from the curriculum documents for Estudo do Meio (Middle Study) for primary school educators, resources provided by the Ministry of Education of Portugal. Relevant knowledge, skills, and attitudes were chosen based on application to the present investigation.

3.6 Developmental Psychology Theories of Focus

Shown below are the four theories of developmental psychology that are utilized throughout this study to support the argument for the importance of including developmental psychology principles within educational frameworks and curricula. While numerous different theories of developmental psychology can all be applied to educational paradigms, the two highlighted below were chosen specifically for this investigation due to their widely known nature and applicability across various disciplines. It is important to acknowledge that although these two theories referenced below are some of the most foundational guiding theories in educational psychology, many argue that the theories are outdated today (Education Rickshaw, 2019). Primarily, these claims rely on the more recent empirical evidence stating that, despite the foundational principles put forth by these two theorists, human development occurs in discontinuous stages rather than what Piaget suggests for example. Furthermore, the article by Education Rickshaw (2019) notes that educator education should be prioritized to help address

the gap between education research and educator practice. Taking this into account within the context of the present work using these foundational theories was a purposeful decision to help portray arguments presented due to their novelty in academic discussion. Future research could benefit from investigating the present question using more advanced and updated theories of developmental psychology.

Jean Piaget: Theory of Cognitive Development	Jean Piaget is recognized as a major founder within the field of cognitive and developmental psychology. His theory of cognitive development emerged through his experience as a trained biologist due to his interest in epistemology and the origins and nature of knowledge (Kazi & Galanaki, 2020). Piaget's work within the realm of childhood cognitive development led to key identifiable themes that are still widely utilized to this day. Although many advances have been made since the time of Piaget's groundbreaking work in the mid-18th century (Kazi & Galanaki, 2020), these primary principles are still relevant and applicable to discussions on developmental psychology. Understanding the key concepts of Piaget's theory is crucial because it supports the foundational framework of understanding how children actively construct knowledge, experience cognitive stages, and much more (Byrnes, 2008).
	Byrnes (2008) discusses these primary concepts of the theory as a set of five major themes. The first is regarding constructivism, a third alternative epistemological stance emphasizing that children actively construct their understanding of the world through interactions and experiences. He believed and advocated for the importance of operative knowledge, arguing that change and transformation produce knowledge (Blake & Pope, 2008). This challenges the majority of traditional views on passive learning. One of Piaget's most widely known concepts within his theory of cognitive development is the notion that child cognitive development occurs in distinct stages and cognitive abilities are organized into coherent mental structures (Arnett & Jensen, 2018). These distinct stages are organized into a sequential progression of cognitive abilities and limitations that children exhibit as they mature: the sensorimotor, the preoperational, the concrete operational, and the formal operational. The present work will focus on middle childhood which primarily aligns with children within the concrete operational stage. The concrete operational stage represents a significant advance in how children can make use of logical principles for solving problems. Piaget observed that at this stage, children were able to utilize conservation, classification, and seriation when problem-solving (Kazi & Galanaki, 2020).
	Another concept within Piaget's theory focuses on the gradual construction of ideas such as object permanence, causality, conservation, number, space, and time (Byrnes, 2008). Through this, Piaget suggests the progression from the passive construction of these concepts to the active engagement in their construction. This further highlights the

	critical role that cognitive development plays in shaping children's understanding of the world. Furthermore, children seek to balance their existing mental structures, identified as assimilation, with new information and experiences, known as accommodation. This process of seeking equilibrium helps to drive cognitive development by promoting adaptation and revising mental schemas. Piaget believed that once a balance between one's mental schema and the external world is achieved, children are in equilibrium (Blake & Pope, 2008). Finally, Piaget's theory concludes with the importance of highlighting the connections between early cognitive development and later stages of thinking (Byrnes, 2008). With this, the theory can reinforce the understanding of the development of cognitive abilities throughout an individual's lifespan. When looking at how Piaget's theory of cognitive development applies to education, correlations can be drawn across multiple areas of discussion. Blake and Pope (2008) provide valuable insight into the application of the theory in education. The principles of Piaget's theory allow teachers to better understand their students' cognitive levels and align their teaching strategies accordingly. In turn, this supports educators in aligning their teaching strategies with their students' cognitive abilities depending on the stage of cognitive development their students fall within. Additionally, Piaget's theory highlights the importance of the conservation of consistency, particularly within the developmental stage of the age range of focus for the present work. Conservation of constancy is crucial for abstract thinking, problem-solving, and discerning relevance in academic tasks. All of these ideas are extremely important components of teaching in environmental education.
Lev Vygotsky: Sociocultural Theory of Cognitive Development	Vygotsky's Sociocultural Theory of Cognitive Development presents another foundational framework in developmental psychology and the field of psychology as a whole. His theory emphasizes the role of social interaction and cultural context in shaping cognitive development (Verenikina, 2003). Unlike Piaget, Vygotsky believed that cognitive development is a dynamic process that occurs through social interaction and collaboration with others, as well as through cultural tools and artifacts that mediate learning. He believed that learning is an active and social process that was completely separate from the independent stages of development argued by Piaget (Semmar & Al-Thani, 2015). Vygotsky never considered himself to be an active investigator purely within the realm of child psychology and educational psychology. Rather, what he was most interested in exploring was the interconnection between the larger culture of humankind and the development of the individual (Bodrova, 1997). Vygotsky's theory states that no individual development can be completely or best understood in isolation from its cultural context.

Central to Vygotsky's theory lie several key components that make up many of the arguments he makes throughout the theory. One of the most commonly utilized concepts of Vygotsky's within the realm of education is the Zone of Proximal Development (ZPD). At the most basic level, the ZPD references the distance between what an individual can do without support and when an individual begins to require support (Verenikina, 2003). With this concept, Vygotsky states that the level of independent performance or the actual level of development does not adequately describe the development of the said individual. With this, he implies that the higher level of development is supported through guidance and collaboration to complement and build upon an individual's existing capabilities. The ZPD highlights the importance of providing learners with appropriate levels of challenge and support to facilitate learning and cognitive growth. Through scaffolded instruction, educators can guide students through tasks that are just beyond their current level of ability, helping them to acquire new skills and knowledge (Semmar & Al-Thani, 2015).

Another key concept embedded within Vygotsky's is scaffolding. Scaffolding refers to, at a simplified level, the support provided by more knowledgeable individuals to help learners achieve their learning goals (Semmar & Al-Thani, 2015). This support involved in the idea of scaffolding could take various forms, including verbal cues, prompts, modeling, or encouragement. Scaffolding is essential for guiding learners through the ZPD, enabling them to gradually develop independence and mastery over time (Verenikina, 2003). By providing structured support and gradually decreasing the support as learners gain proficiency, educators can facilitate more effective and lasting learning outcomes.

With all of this in mind, Vygotsky's sociocultural theory of cognitive development provides valuable insights and application within the realm of education. Blake and Pope (2008) speak to the role that Vygotsky's theory has in the classroom. Vygotsky's theory emphasizes the importance of challenging students just beyond their cognitive abilities which allows them to grow and collaborate with others. In addition, his theory encourages the importance of social interaction between peers and educators for the learners. Taking into account the cultural context of the learner helps to support various ways of learning including values, beliefs, and ways of knowing. All of these components are extremely relevant to the discussion of environmental education.

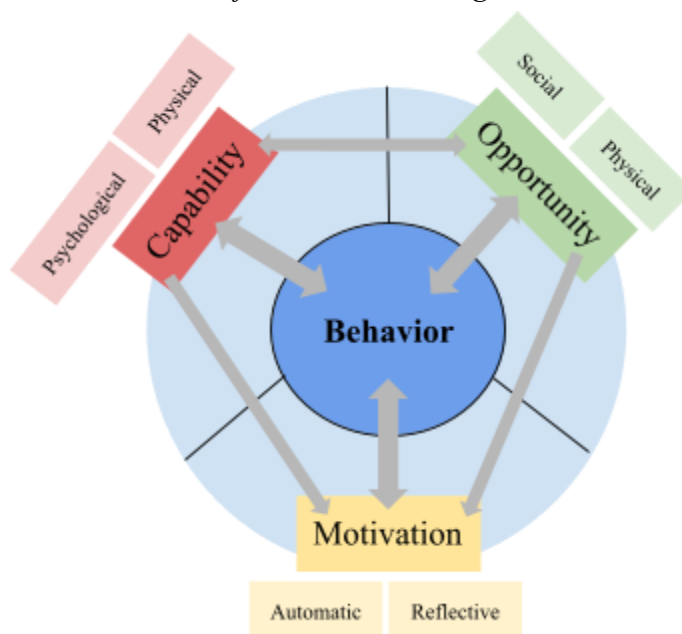*3.7 Introduction to the COM-B Model of Behavioral Change*

Figure 1. Current COM-B model for behavioral change. Visual created by the author, content adapted from Khalilollahi et al. (2022) and Michie et al. (2011).

The COM-B model of behavioral change proposes a comprehensive framework model for understanding behavior, how behavior can be changed, and to support the development of behavior change interventions (Khalilollahi et al., 2022). Many alternative approaches to looking at components of behavior revolve around taking an ecological approach or a socio-ecological approach. What sets the COM-B model apart is its ability to provide a framework for behavior change as well as highlight the multitude of influential factors on behavior. The COM-B model revolves around the idea that behavior is a result of the interaction between three different components: capability, opportunity, and motivation (Khalilollahi et al., 2022; see Figure 1). Susan Miche and colleagues developed the model in 2011 with the primary goal in mind of supporting an initiative to work towards creating lasting behavior change in humans (Michie et al., 2011). Although the majority of existing literature utilizing the COM-B model as a framework for their respective arguments falls within the realm of public health, the model can be applied to a variety of disciplines where behavioral change is possible.

The COM-B model of behavioral change was selected as the framework to support the argument of the present work due to its multifaceted application within the realm of behavior change. By suggesting that the interaction between the three primary components, capability, opportunity, and motivation, influence behavior and behavior change, the model can take into account all of the factors inside and outside the individual that lead to behavior (Timlin et al., 2020). As visible in Figure 1, the different arrow types represent the various nature of influence between components. Miche et al. (2011) speak about these interactions between the model's components as a way to understand how a certain intervention could impact one, or multiple parts of the system. Furthermore, Timlin et al. (2020) describe how this model positions the motivation component as the central mediator of the model so that capability and opportunity components can impact behavior both directly and indirectly. Lastly, the model suggests that

each component can be divided into two subdivisions each. Miche et al. (2011) state that all six of these sub-divisional components are necessary for a certain behavior to be enacted.

Placing the present work into the context of the COM-B model is looking at the specific energy conservation behaviors in primary school students in Portugal and the capabilities, opportunities, and motivation factors that impact the target behavior. While the present work isn't aimed at developing a textbook intervention, the intervention can be viewed through the educational focus of the present work.

4. Results and Discussion

The present study, through an extensive review of current literature, was able to develop arguments supporting each dimension of the COM-B model of behavioral change. The identification of commonalities and themes across the literature from the multiple disciplines being drawn from in this work allowed for the primary conclusions of the study. The conclusions provide insight into the implementation of developmental psychology principles into approaches to environmental education. Below, the findings have been organized using the three dimensions of the COM-B model of behavioral change: capability, opportunity, and motivation. Within each subsection, comparisons were drawn between the aforementioned theories of developmental psychology and how certain educational approaches are best fit for encouraging behavior change. Although these two disciplines have yet to be integrated in such a way, the present work provides important insight into the importance of taking into account the cognitive development of children throughout their learning process. This is particularly salient when it comes to developing curriculums and educational approaches for disciplines within environmental education as children remain the future decision-makers for a sustainable society.

The present work focuses specifically on supporting the development and implementation of effective educational approaches for teaching primary school students about energy and energy conservation. To this end, the findings of this study have been placed within the specific aim of the study. Each section will also draw from the Estudo do Maio curriculum (Table 1) to situate findings and develop appropriate recommendations for the target audience.

4.1 Capability

Looking first at the capability dimension of the COM-B model, this dimension references an individual's psychological knowledge and physical skills to engage in or perform a certain activity. As mentioned above, across literature it has been identified that each dimension can be split up into two subsections. In the case of the capability dimension, these two subsections consist of psychological and physical compatibility. Through the present

Turning first to the psychological subsection of the capability dimension, one connection rose to the top as the most applicable for the question at hand. The psychological subsection refers primarily to an individual's ability and position to be able to engage in the compulsory thought processes, comprehension, and reasoning to perform the target behavior (Willmott et al., 2021). Based upon this alongside the theories of developmental psychology referenced in this paper, Piaget's concept of the stages of cognitive development within his larger theory of cognitive development aligns well with this dimension's subsection. As the present work is focused on children in primary school, from age six to ten, these children can be placed within the concrete operational stage of cognitive development. This stage in development shows children exploring a greater understanding of logic, the ability to understand the concept of

reversibility, as well as understanding the idea of conservation (Arnett & Jensen, 2018). These patterns in cognitive development highlight how children at this age can use tools such as organization and can understand that when some things have been changed there are ways for them to return to their original state. In addition, the notion of conservation becomes more understood when students can understand that the same amount of a substance, for instance, remains consistent even when taking a different shape.

Furthermore, children at this age become less egocentric, can think more about others, and are less completely focused on themselves. Despite these significant advances in cognitive development, many children at this age are not yet able to completely understand abstract or philosophical ideas. They still rely on physical ideas that they can see in the real world. All of these components provide invaluable insight into the importance of educators and the educational system's knowledge of the cognitive capabilities of the students in focus.

Applying this to effective education for primary school students on topics of energy and energy conservation, the concrete operational stage should encourage educators to be informed on the cognitive abilities of their students (Blake & Pope, 2008). Topics regarding energy and energy conservation taught in the classroom should be tangible ideas with physical stimuli that students can relate to in the real world. This could look like teaching children at this age about the different types of renewable and non-renewable energies, where they come from on the Earth, and what different types of energy they produce.

Turning next to the physical capability subsection of the dimension, this refers to whether the individual carries the necessary knowledge and skills needed to perform the target behavior. In this case, the target behavior is the encouragement of energy conservation behaviors in students. Based on the exploration of the present work, Vygotsky's Zone of Proximal Development (ZPD) theory within his larger sociological theory of cognitive development maps well onto this subsection. This part of the theory relates well to the concepts highlighted by Piaget above because there lies importance in identifying the cognitive abilities of the student based on their stage and development, but Vygotsky speaks to the importance of a certain level of challenge to promote lasting understanding of the topics at hand. The role of educators, as well as other actors in the life of the student, is to promote an appropriate level of challenge for the students leading to growth in cognitive understanding (Semmar & Al-Thani, 2015).

When looking at these concepts in terms of the aim of the present work, topics in energy and energy conservation should be taught acknowledging the appropriate level of cognitive development of the student, but also providing a space where educators can support students with an appropriate level of challenge. Some examples of this in the classroom could include educators posing questions to students about how they believe the movement of energy looks in their place of living. This question, although not necessarily something that is right in front of the student, allows them to think in a more complex manner with the support of their educator. Duhn (2012) speaks to the fact that many existing projects for teaching topics in environmental education rely on simpler topics such as recycling and waste management. In reality, more complex topics can be taught at age-appropriate levels when taking into account a student's cognitive capabilities.

4.2 Opportunity

Turning next to the opportunity dimension of the COM-B model, this dimension refers to the factors that lie outside of the individual that prompt the execution of the target behavior or make the target behavior possible (Khalilollahi et al., 2022). The first subsection of this

dimension is the social opportunity which highlights the social and cultural background surrounding the individual to help create the opportunity (Khalilollahi et al., 2022; Willmott et al., 2021). This notion aligns well with Vygotsky's central idea in his sociocultural theory of cognitive development as one of his guiding principles relies on the idea that social interaction and cultural context are central to the shaping of cognitive development in children (Verenikina, 2003). Social opportunity is extremely relevant within the discussion of teaching concepts of environmental education and sustainability because it highlights the critical role that social surroundings play in a child's understanding of the topics at hand.

Applying this specifically to teaching topics in energy and energy conservation in primary schools, showcases the responsibility held by educators, parents, and guardians alike to support a social and cultural environment that promotes and encourages the target behavior. One important example of this in the context of the present argument is the impact that providing a learning experience for educators can have on their ability to appropriately and effectively teach topics of sustainability (Warren et al., 2014). This recommendation is far more targeted toward educational policymakers as they have just as much of a responsibility in the development of effective educational approaches as educators do.

The second subsection of the opportunity dimension of the COM-B model is the physical opportunity. Physical opportunity refers to the opportunities to engage or perform the target behavior provided by the environment (Khalilollahi et al., 2022). Willmott et al. (2021) also recognize that physical opportunity relates to the resources provided by the environment for the target behavior to be learned. Through the present investigation, certain concepts contributing to Piaget's theory of cognitive development help to support the physical opportunity subsection of the model. Piaget's notion of constructivism, the third alternative epistemological approach to education, suggests that children develop their understanding of the world around them through direct interactions and experiences (Blake & Pope, 2008). In this effect, Piaget also references the concepts of assimilation and accommodation. These concepts highlight the ways in which children of this age are constantly learning from the experiences around them and using their observations as a way to help construct and modify their understanding of the world around them.

The primary school educator interviewed for this study referenced and acted on the importance of children as learners having access to hands-on, real-world experiences. While she implemented these hands-on experiences by supporting her students in making observations in the forested area around the school, these practices can be implemented in a variety of ways. Looking specifically at the topic of education in energy conservation and energy in general, educational curricula for students of this target age should prioritize hands-on and real-world experiences to promote learning. This could be implemented through field trips to a solar farm or a hydroelectric dam to teach students about the basics of renewable energy sources. This could also look like making the classroom an interactive learning space where students move around the room and learn about the various ways the production and extraction of non-renewable energy sources deplete and erase habitats. The list is expansive when it comes to developing learning opportunities for students using the power of hands-on experiences. When it comes to teaching about topics in environmental education and sustainability, it is important to develop curricula that offer the students the opportunity to further construct their ideas on how the world works. This is where students will learn to grow their understanding of how things can and should work, which, in turn, will support their critical thinking and problem-solving skills for future endeavors.

4.3 Motivation

Finally, motivation, the central mediator of the COM-B model (Timlin et al., 2020), refers to the brain processes that energize and direct the execution of the target behavior, in addition to efforts such as goal setting or conscious decision-making (Michie et al., 2011). As with the other two dimensions, the two subsections that constitute the motivation dimension are automatic and reflective motivation. Turning first to reflective motivation, this speaks to the importance of external drivers of motivation outside of the individual's innate cognitive processes (Khalilollahi et al., 2022). Reflective motivation results in outcomes attributed to high cognitive processes like setting goals and holding values and beliefs towards the target behavior. In a similar way to the social subsection of the opportunity dimension, reflective motivation can be seen as highly connected to the principles put forth by Vygotsky's sociocultural theory of cognitive development. As previously mentioned, children at the target age of this paper are highly influenced by those surrounding them, particularly in their immediate community (Arnett & Jensen, 2018). A large component of this influence can be seen in the transmission of guiding values and beliefs when it comes to influencing pro-environmental behaviors (Mosca et al., 2024). With this in mind, this connection promotes the importance of how values and beliefs surround children and acknowledges the role that these outside factors play in children at a lasting and pivotal time in their lives.

Applying this to environmental education in particular, parents and educators should be informed and aware of their own beliefs and values that they hold regarding topics within sustainability. If looking at applying these ideas specifically to promote energy conservation behaviors in these young students, educational approaches should include curricula that can be brought home with the student. By promoting familial practices of energy conservation and supporting a positive parental perception of energy conservation practices at home, students will have the motivation to set their own personal goals, values, and beliefs regarding the importance of energy conservation. This might look like educators introducing a new energy conservation habit every weekend for students to bring home and work in conjunction with their families to understand the importance of their actions.

The second, and final subsection of the model, is automatic motivation. Automatic motivation refers to motivation that arises from intrinsic sources and preferences (Khalilollahi et al., 2022). These motivations are often outside of an individual's awareness such as emotional responses, habits, and intuitions (Garcia, 2024). As touched on earlier in the paper, children at this stage of development are constantly filled with curiosities, questions, and preferences for exploring, learning, and problem-solving (Arnett & Jensen, 2018). With this in mind, parallels can be drawn once again to Piaget's theory of cognitive development concerning both the theory overall and his identified stages of cognitive development. The target age for students referenced in this paper falls into the concrete operational stage and one large component of this stage is the heightened motivation for using learned logical principles to approach more problem-solving (Kazi & Galanaki, 2020). This aspect connects to Piaget's concept of constructivism and how children go about learning these principles. Through questioning and curiosity, children can create a more concrete understanding of a basic real-world issue.

Another intrinsic motivational source arises from the presence of emotion toward or about the target behavior. Schneider and Van der Linden (2023) speak to the proven notion that the fostering of an emotional investment in an issue supports lasting behavior change. Taking this into account, the development of an emotional investment in topics of sustainability in students can fall within the bounds of automatic motivation. Developing educational

programming and approaches fostering an emotional investment of the students in the target issue and target behavior could lead to lasting and more effective behavior change.

When thinking about how these conclusions could be implemented in a primary school classroom, the Lisbon educator interviewed for this project provided examples of concrete ways in which she has helped to support emotional investment in her students. By creating activities that encourage her students to make observations about all the life that they see out in the forest and asking probing questions about the importance of ecosystems (Educator, 2024), she is supporting the creation of an emotional investment in her students. Using these ideas to inform recommendations for education in energy conservation, educators could work to support the fostering of emotional investment by teaching students about all the ways their everyday lives require energy and where that energy is really coming from. Asking questions to promote curiosity and ideas for problem-solving helps to support the intrinsic motivation in each individual. This, in turn, will help support behavioral change at a deeper and longer-lasting level.
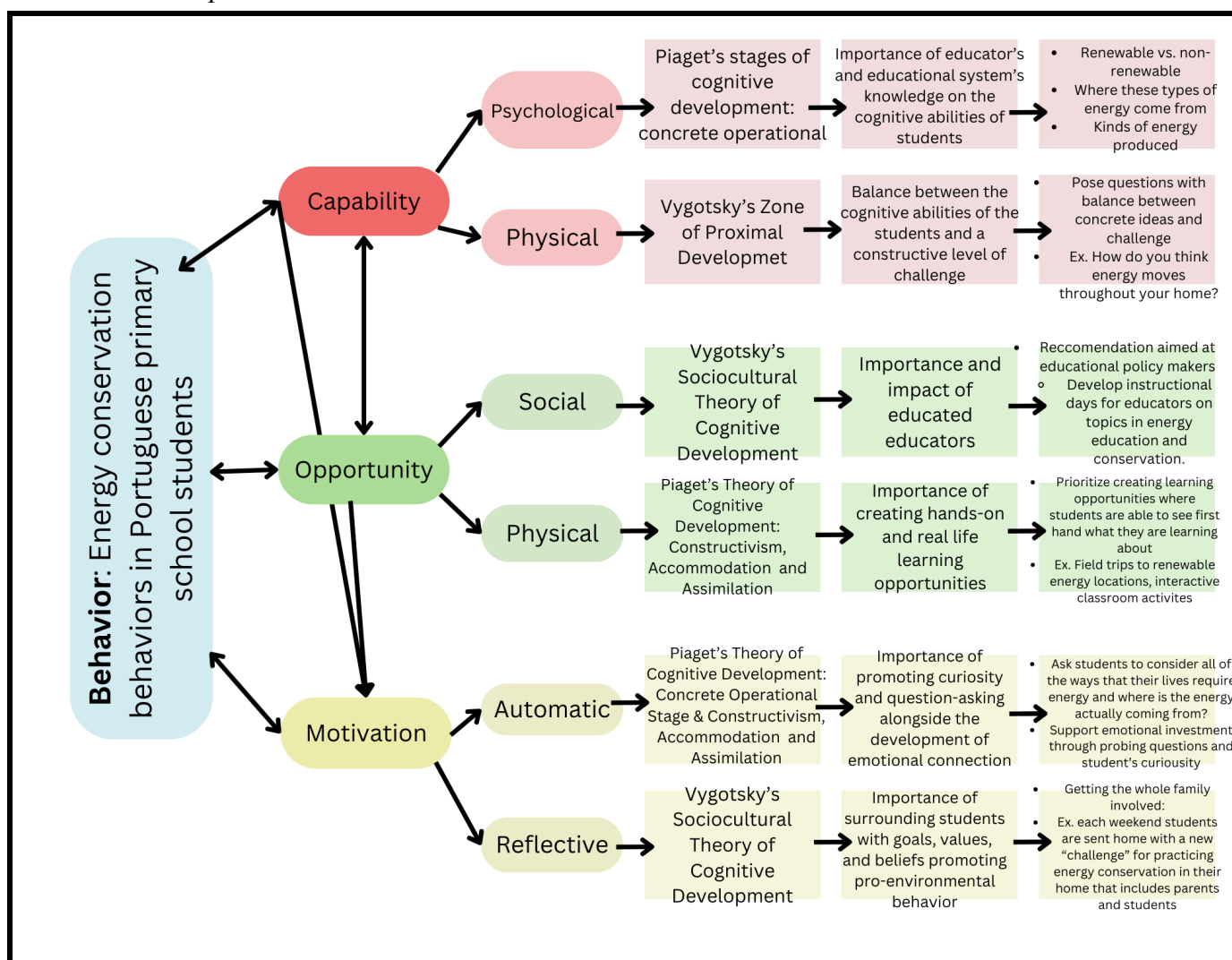
4.4 Result: Updated COM-B Model

Figure 2. Updated version of the COM-B model of behavioral change. This model was developed by the author based on the results and discussion of the present study. The updated

model displays the developmental psychology theory, relevant principles provided by said theories, and generalized recommendations for teaching topics in energy conservation for primary school students. These elements are aligned with each of the six subsections of the three dimensions of the original COM-B model.

5. Conclusion

This study found that principles of developmental psychology provided through two guiding theories of developmental psychology can support, inform, and enhance curricula for teaching topics in environmental education for primary school students in Portugal. It is extremely important to recognize the crucial role that effective education for students has in promoting pro-environmental behaviors. The present work can be placed into the context of the growing global need for a climate-literate society. Therefore, the present work suggests that effective environmental education approaches can, and should, involve principles of developmental psychology to curate a curriculum aligned with the capabilities, opportunities, and motivations of students at a specific age. This will aim to promote long-lasting pro-environmental behavioral changes in the future generations responsible for maintaining a sustainable and aware society.

Portugal, in particular, while there are efforts toward wider implementation of environmental education programming, the present work highlights the shortcomings likely affecting its wider adoption. Implementation issues reside at a governmental and political level, while drawbacks in efficacy are present at a curricular level. Framing the findings of the present work within a model of behavioral change lends itself to a greater understanding of how developmental psychology is particularly informative when discussing children in middle childhood. Taking these factors into account reiterates that effective educational approaches rely on passionate and purposeful programming. The impressionability and desire of learning that children possess at the age of interest for the present work should be acknowledged and taken into account when developing educational programming, especially when it comes to creating lasting behavior change. Promoting a well-rounded and knowledgeable society of future decision-makers should remain a priority.

While the guiding research question lends itself to an extremely expansive discussion and is only scratching the surface of what is left to explore, the present work provides important insight for future and more in-depth analysis. This is only one piece of a large and multidimensional puzzle to help begin the discussion on how developmental psychology should be a tool when it comes to curriculum development. Educators should have the opportunity to learn about the cognitive abilities of their students, educate themselves on the topics they are teaching, provide an appropriate level of challenge for their students, and help promote emotional investment for the target behavior in their students. These recommendations are highly applicable to how the available curriculum for teaching topics in environmental education could be improved. Not only does the Estudo do Meio curriculum lack specificity on less commonly covered topics, such as energy, but it also lacks information on how educators should teach certain topics and why those approaches are important. By working to create educational curriculums and approaches using these recommendations, educators, parents, and educational policymakers can support pro-environmental behavioral changes in primary school students.

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7. Appendix A.

Terms and Concepts

Pro-environmental behaviors	Also known as conservation behaviors, environmentally friendly behaviors, environmentally significant behaviors, environmentally sustainable behaviors, or responsible environmental behaviors. Pro-environmental behaviors are a result of an understanding that human behaviors are a major contributor to a multitude of environmental issues (climate change, pollution, loss of biodiversity). Furthermore, pro-environmental behaviors account for the understanding that human behavior can both mitigate these negative effects, but can also easily exacerbate them (Lange & Dewitte, 2019). Most people are not in positions of power where they can directly influence government or corporate policy, but all people can responsibly consume materials and energy in their daily lives and can choose to adopt behaviors that are comparatively better for the environment (Osbaldiston & Schott, 2011).
Energy literacy	Energy literacy is an area of understanding regarding basic energy-based knowledge coupled with an understanding of the ways that energy production and consumption impact the environment. It also includes the understanding of how energy is used day-to-day and encourages a reduction in energy consumption. There have been three different dimensions identified within the definition of energy literacy: knowledge, attitude, and behavior (Martins et al., 2020b; DeWaters & Powers, 2013) Energy literacy encompasses scientific, technological, and environmental literacy and includes the cognitive, affective, and behavioral domains of psychology. Energy literacy promotes character development and instills virtue through education (Rohmatulloh et al., 2023).
Renewable energy transition	The renewable energy transition refers to the global energy sector's shift from fossil-based systems of energy production and consumption (oil, natural gas, and coal) to renewable energy sources (wind, solar, lithium batteries). Renewable energy has become more prevalent in the energy supply where electrification and improvements in energy storage are all key drivers of the energy transition (S&P Global, 2020). The world is currently experiencing a fourth energy transition focused on fighting global climate change through the

	decarbonization of the energy supply and consumption patterns. It is currently driven by the climate change agenda, technology developments and innovation, increased energy efficiency, competitive economies, enhanced energy security, development of affordable energy solutions, and modernization of the energy sector from traditional energy systems (Kabeyi & Olanrewaju, 2022).
Sustainable development	Sustainable development can be defined as development that can both meet the needs of the current population and the environment without compromising the ability of future generations to be able to meet their own needs. There are three primary dimensions within the definition: the economic, the ecological/environmental, and the social. A sustainable society contains the integration of all three dimensions (Ojala, 2019).
Education for sustainable development	Education for sustainable development prepares people from areas of life to plan for, cope with, and find solutions for issues that threaten the sustainability of our planet. The understanding and addressing of these sustainability issues are derived from the three dimensions of sustainable development: environment, society, and economy (UNESCO, 2005). Education for sustainable development revolves around a new vision of education that empowers all learners to assume responsibility for creating and enjoying a sustainable future (O'Flaherty & Liddy, 2017).
Climate literacy	Climate literacy is a relatively novel concept viewing the intersection between climate science and environmental education approaches and strategies. Climate literacy aims to promote, stimulate, and cultivate pro-environmental values, attitudes, and behavior through the same three dimensions: knowledge, attitude, and behavior (Kolenatý et al., 2022).
Positivist paradigm	Also known as the "scientific research paradigm", relies on the use of traditional scientific methods to study and understand a target question. It focuses on observable facts and empirical evidence and often aims to establish a cause-and-effect relationship. The paradigm relies on the idea that the physical and social world exists separate from humans' knowledge (Taylor et al., 2013)
Developmental psychology	Developmental psychology studies human growth and development throughout their lifespan including physical,

	cognitive, social, intellectual, personality, and emotional components of growth. Developmental psychology explores how people develop and adapt at various stages across their lifetime and is essential to an understanding of how humans learn and mature (American Psychological Association, 2014). The present work focuses primarily on the cognitive, social, and emotional components of human psychological development.
Mental structures	Recognized as cognitive systems that can organize an individual's thinking into coherent thinking patterns to ensure that all thinking of that individual can occur at the same level of cognitive functioning (Arnett & Jensen, 2018)