

FRAMING GROWTH

Exploring the transformative power of
photography for students



**Hochschule
für nachhaltige Entwicklung
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Preface

This discussion paper is a follow up on an earlier paper published in this same discussion series where we explored the value of photography in education and science (Currie & Göttert 2023). The first paper was from an educator's perspective. For this present exploration, students, representing the field of environmental sciences, stand as co-authors, lending their unique perspectives and experiences to enrich our discourse on the topic. The co-authorship of this paper signifies our commitment to amplifying student voices, providing them with a space to share their journeys of discovery and personal growth through photography. We first introduce the benefits of using photography in an educational context followed by a description of our approach to the paper. Our findings unveil the multifaceted benefits derived from photography. We gathered insights and reflections that highlight the impact of photography on learning, skills development, communication, documenting, and reporting. Furthermore, we highlight the more personal and unexpected outcomes such as the personal growth derived from photography that emerged from our reflections. Lastly, we discuss the limitation and challenges and ethical issues related to photography and provide our advice in terms of using photography in educational spaces. The paper is then concluded by encouraging educators to make more use of the visual medium in their work. Through anecdotes and reflective narratives, it is our hope that this collaborative endeavour will inspire educators, students, researchers, and institutions to acknowledge and harness the transformative potential of photography in education. As learners, educators and as co-authors, we advocate for the inclusion of visual elements, fostering a more holistic and engaging learning environment that empowers learners to see the world through a new lens.

Summary

This discussion paper aims to shed light on the benefits and value of photography from a student perspective. The starting point and central element of this paper are reflections from selected students representing the field of environmental sciences. Students contribute as co-authors of this paper. The student co-authors were asked by the lead authors to share their experiences with photography. The lead authors analysed these reflections using a grounded theory approach. On this basis, we were able to identify four key areas that are of particular importance: 1) learning, 2) skills development, 3) communication, and 4) personal development. In addition, we considered the limitations and challenges in the use of photography for students, ethical aspects to be considered when using photography in the context of science and education, and student advice for educators. The lead authors' interpretation and enrichment of the student reflections led to interesting trains of thought, which are brought to light in our discussion. Our paper highlights the importance of viewing the subject of photography from diverse perspectives. By doing so, various insight and outlier perspectives emerged that were not expected. The student experiences underline the importance of the close connection between learning and emotional recall. In particular, the topic of personal development and the aspect of joy and fun in the context of photography were highlighted. It also became clear that the students' point of view emphasized the process of taking photographs and sometimes even value this process more than the end result – the actual photo. Finally, we also addressed our ethnic, cultural, and disciplinary bias and mentioned the digital divide. To sum up, the integration of technology and active participation through photography not only enriches education but also empowers students with invaluable skills that extend beyond the classroom, the lab or the field. By immersing students in visual and experiential learning, this paper advocates for a holistic approach that fosters deeper comprehension, heightened curiosity, and lifelong learning.

Key words: education, personal development, photography, skills development

Zusammenfassung

Ziel dieses Diskussionspapiers ist es, die Vorteile und den Wert der Fotografie aus studentischer Sicht zu beleuchten. Ausgangspunkt und zentrales Element dieser Arbeit sind Überlegungen ausgewählter Studierender der Umweltwissenschaften, die als Ko-Autoren dieser Arbeit mitwirken. Die studentischen Ko-Autoren wurden von den Hauptautoren gebeten, ihre Erfahrungen mit fotografischen Aktivitäten zu teilen. Die Hauptautoren analysierten diese Reflexionen mithilfe eines Grounded-Theory-Ansatzes. Auf dieser Grundlage konnten wir vier Schlüsselbereiche identifizieren, die von besonderer Bedeutung sind: 1) Lernen, 2) Kompetenzentwicklung, 3) Kommunikation und 4) persönliche Entwicklung. Darüber hinaus haben wir die Einschränkungen und Herausforderungen beim Einsatz von Fotografie für Studenten, ethische Aspekte, die beim Einsatz von Fotografie im Kontext von Wissenschaft und Bildung zu berücksichtigen sind, sowie studentische Ratschläge für Dozenten berücksichtigt. Die Interpretation und Einschätzung der studentischen Reflexionen durch die Hauptautoren führte zu interessanten Überlegungen. Unser Papier unterstreicht, wie wichtig es ist, das Thema Fotografie aus verschiedenen Perspektiven zu betrachten. Dadurch entstanden verschiedene Erkenntnisse und „Ausreißer“, die so im Vorfeld der Arbeit nicht erwartbar waren. Die Erfahrungen der Studierenden unterstreichen die Bedeutung des engen Zusammenhangs zwischen Lernen und emotionaler Erinnerung. Besonders hervorgehoben wurden die persönliche Entwicklung und der Aspekt von Freude und Spaß im Kontext der Fotografie. Es wurde auch deutlich, dass die studentische Sichtweise den Prozess des Fotografierens in den Vordergrund stellt und diesen Prozess manchmal sogar stärker gewichtet, als das Endergebnis – das eigentliche Foto. Abschließend gingen wir auch auf unsere ethnische, kulturelle und disziplinäre Voreingenommenheit ein und erwähnten eine bestehende digitale Kluft. Zusammenfassend lässt sich sagen, dass die Integration von Technologie und aktiver Beteiligung durch Fotografie nicht nur die Bildung bereichert, sondern Studierenden auch wichtige Fähigkeiten vermittelt, die über den Unterricht, das Labor oder den Feldeinsatz hinausgehen. Durch die Einbindung der Studierenden in visuelles und erfahrungsbasiertes Lernen plädieren wir mit vorliegendem Diskussionspapier für einen ganzheitlichen Ansatz, der tieferes Verständnis, gesteigerte Neugier und lebenslanges Lernen fördert.

Schlagerworte: Bildung, Fotografie, Kompetenzentwicklung, persönliche Entwicklung

Table of contents

Preface	iii
Summary	iv
Zusammenfassung	v
1 Introduction	1
2 Methods & approach	3
2.1 Identifying student co-authors	4
2.2 Approaching co-authors	5
2.3 Grounded themes and categories.....	5
3 Student perspectives on photography in education and personal development	7
3.1 Learning.....	7
3.1.1 <i>Enya's learning journey with photography</i>	7
3.1.2 <i>Oliver's learning journey with photography</i>	9
3.1.3 <i>Michael's learning journey with photography</i>	11
3.1.4 <i>Laura's learning journey with photography</i>	12
3.1.5 <i>Valentin's learning journey with photography</i>	15
3.1.6 <i>Yasmin's learning journey with photography</i>	17
3.1.7 <i>Distilling the students' perspectives on photography and learning</i>	18
3.2 Skills development.....	20
3.2.1 <i>The skills Enya developed through photography</i>	21
3.2.2 <i>The skills Oliver developed through photography</i>	22
3.2.3 <i>The skills Michael developed through photography</i>	23
3.2.4 <i>The skills Laura developed through photography</i>	25
3.2.5 <i>The skills Valentin developed through photography</i>	26
3.2.6 <i>The skills Yasmin developed through photography</i>	28
3.2.7 <i>Distilling the student's perspective on photography and skills development</i>	28
3.3 Using photography to communicate	29
3.3.1 <i>How Enya communicates with photography</i>	29
3.3.2 <i>How Oliver communicates with photography</i>	29
3.3.3 <i>How Michael communicates with photography</i>	30
3.3.4 <i>How Laura communicates with photography</i>	32
3.3.5 <i>How Valentin communicates with photography</i>	33
3.3.6 <i>How Yasmin communicates with photography</i>	34
3.3.7 <i>Using photography for documentation</i>	38
3.3.8 <i>Distilling the student perspectives on photography and communicating</i>	39
3.4 Personal development.....	40
3.4.1 <i>Self-motivation</i>	41
3.4.2 <i>Entertainment, stress relief and joy</i>	42
3.5 Limitation and challenges	45
3.6 Ethical issues	46
3.7 Student advice for educators using photography in teaching and learning.....	49
4 Discussion	49
4.1 The significance of diverse perspectives	50
4.2 Unanticipated insights and outlier perspectives	51
4.3 The dichotomy of learning content and emotional recall	52

4.4	Personal development and the overlooked joy of photography	53
4.5	Emphasizing the process over the end result	54
4.6	The lasting effect of photography	54
4.7	Emphasizing ethics	55
4.8	Recognizing our bias and mentioning the digital divide.....	56
5	Concluding remarks.....	57
6	Acknowledgements.....	59
7	References	59
8	Appendix	62

List of figures

Figure 1. A photo of a sunset at the Zambezi river in northern Namibia (left) triggers the photographer's memories of associated species, such as the pied kingfisher (<i>Ceryle rudis</i> ; right). Photos: Thomas Göttert.....	3
Figure 2. Sharpening observational skills: closer inspection reveals that two Canadian geese (<i>Branta canadensis</i>) are part of a large flock of greylag geese (<i>Anser anser</i>). Photo: Thomas Göttert.....	3
Figure 3. Orange-breasted sunbird (<i>Anthobaphes violacea</i>); photo: Enya Munting.....	9
Figure 4. Juvenile Eurasian jackdaw (<i>Corvus monedula</i>) begging for food; photo: Oliver Rolfes	10
Figure 5. A white-backed woodpecker (<i>Dendrocopos leucotos</i>) defends its tree against another, a photograph which helped Oliver learn about a species he never knew about before. Photo: Oliver Rolfes.....	11
Figure 6. A locust photographed to show anatomical features to add to zoological lecture notes. Photo: Laura Feldenz.....	13
Figure 7. A photo of a lunar eclipse which helped Laura gain a better understanding of the physical process of lunar eclipses. Photo: Laura Feldenz	14
Figure 8. A photograph of a melanistic European adder (<i>Vipera berus</i>) which marked a memorable and satisfying experience for Valentin. Photo: Valentin Backa	16
Figure 9. Scorpion under a florescent light; photo: Yasmin Markides	17
Figure 10. Stabilimentum on a spider web; photo: Bianca Currie	19
Figure 11. Comparing well managed veld with overgrazed veld by goats in the arid Karoo environment in South Africa. The image is used to demonstrate the impact goats can have on the arid landscape. Photo: Bianca Currie	20
Figure 12. An example of a photo used to identify a plant species, the Kapok bush (<i>Eriocephalus microphyllus</i>). Photo: Enya Munting	21
Figure 13. Mating behaviour of common darter (<i>Sympetrum striolatum</i>); photo: Oliver Rolfes.....	23
Figure 14. Male lion (<i>Panthera leo</i>) performing flehmen response; photo: Michael Klaver.	24
Figure 15. Brown hyaena (<i>Parahyaena brunnea</i>) anal pasting on a blade of grass; photo: Michael Klaver	25
Figure 16. Carpet python (<i>Morelia spilota mcdowelli</i>) from Moreton Island, this photograph brought to light the intricate details of the species for Valentin. Photo: Valentin Backa.....	27
Figure 17. Siamese crocodile (<i>Crocodylus siamensis</i>) from Vietnam revealing diagnostic features of the species; photo: Valentin Backa	28
Figure 18. Lion staring you dead in the eyes; photo: Michael Klaver.....	31
Figure 19. Black rhino (<i>Diceros bicornis</i>) with surgical clamps on its ears – ear notching allows later individual identification; photo: Yasmin Markides	35
Figure 20. Photograph of a lion paw in relation to a human hand to illustrate the size of the paw; photo Yasmin Markides.....	36
Figure 21. Students undertaking vegetation transects during a field trip to Carlitzdorp in South Africa; photo: Bianca Currie.	37
Figure 22. A tendency towards flight behaviour of a red-backed shrike male (<i>Lanius collurio</i>) teaches the photographer to seize the moment. Photos: Thomas Göttert.....	39
Figure 23. Photograph taken during a student field trip used as a reminder of the experience years later; photo: Bianca Currie.....	40
Figure 24. Enya's dad and brother in an old, broken car; photo: Enya Munting.....	43
Figure 25. Summary of student reflections.....	45
Figure 26. A horse and human with both their faces blurred – is this the future of ensuring personal rights to non-human species? Photo: Thomas Göttert	47
Figure 27. The information changes depending on which part of the image section is in focus. Above: Different species appear. Below: The focus is once on <i>Buteo buteo</i> and once on a celestial body. Photos: Thomas Göttert	51
Figure 28. Petri dish showing the diversity of contaminants in a mushroom growing facility, illuminating the unseen; photo: Bianca Currie.....	52
Figure 29. Photograph of a winter landscape, which helped to recall emotions during excursions in that area at a different time of the year. Photo: Thomas Göttert.....	53
Figure 30. Photo quiz used in the classroom; photo of flipchart: Florian Müller; animal photos within photo: Thomas Göttert.....	54

1 Introduction

In today's rapidly changing educational landscape, a shift is underway as institutions increasingly embrace technology as a pivotal tool to captivate and involve students in more dynamic and immersive learning experiences. This transformation recognizes the need to align education with the digital era, offering students a learning environment that not only accommodates their technological fluency but harnesses it to elevate their engagement and understanding (Calderón-Garrido et al. 2022). As traditional teaching methods give way to innovative approaches, technology, in its various forms, emerges as a conduit for enhancing curriculum delivery, fostering interactivity, and encouraging active participation, ultimately pushing the boundaries of modern education.

In this changing educational landscape, one frontier in harnessing technology lies in the integration of photography as an educational tool, particularly within the context of the widespread availability of cell phones in classrooms (Tindell & Bohlander 2012, Doyle et al. 2021). As mobile devices become an integral part of students' lives, the potential to leverage these devices for educational purposes becomes increasingly apparent (Sung et al. 2016, Crompton & Burke 2018). The ubiquity of cell phones provides an opportunity to introduce photography as a versatile and accessible means of enhancing learning. This innovative approach capitalizes on students' familiarity with technology, allowing them to seamlessly bridge their personal experiences with educational endeavours, transforming their devices into instruments to foster learning and inquiry, develop observational skills, and helping learners understand concepts and processes, which can result in more meaningful engagement with concepts and topics. Through the lens of photography, educators are engaging students with contemporary tools for improved knowledge retention and recall, in ways that resonate with their digital-native identities.

Photography, as a versatile tool, offers a multitude of advantages that elevate students' educational experiences by providing a tangible means for students to actively immerse themselves in their subjects. By encouraging students to capture images that resonate with the concepts they are studying, educators are transforming them into active contributors in their own learning journey (Bonnycastle & Bonnycastle 2015, Al-Bahrani et al. 2016). This transition from passive recipients to active creators cultivates a sense of ownership and curiosity, as students navigate their environment with a discerning eye, seeking out connections and visual narratives that align with their coursework.

Cognitively, photography is a potent tool that encourages observation and critical thinking (Eisen 2012, Cordell 2016). In the act of selecting subjects' consideration is given to characteristics of the subject, habitat, behaviour and other related information. These deliberations facilitate a deeper understanding of the subject, prompting students to explore detail, nuances and intricacies. This leads to a more comprehensive grasp and a deeper connection to the learning process and material, and a more meaningful and memorable learning experience.

At its core, photography offers a canvas for creative expression that transcends traditional forms of communication (Ballenger 2014). Through the lens, students can translate abstract concepts into visual narratives that resonate with their personal experiences and perspectives. This creative freedom

not only enhances their connection to the subject matter but also encourages them to approach learning from a unique angle. Whether it's capturing processes over time or abstract concepts, photography empowers students to convey their understanding in innovative ways. Educators can tap into students' diverse talents and modes of communication, fostering a holistic and multidimensional learning environment that caters to individual learning styles and preferences.

Photography is a catalyst for active learning by offering students the opportunity to immerse themselves fully in the process of capturing images. This active engagement moves them from passive listeners to proactive participants in their learning journey. Through the act of taking a photograph, the process inherently encourages curiosity and exploration, as students venture beyond textbooks to discover tangible representations of their subjects. By assuming an active role in curating visual content, students cultivate a sense of ownership over their learning, anchoring abstract ideas in concrete experiences that bolster comprehension and retention.

Photography serves as an amplifier of knowledge retention (Vander Have 2012), leveraging the visual medium's unique ability to create lasting impressions in students' memory. We believe that this applies to students in general and not only those that represent the field of environmental sciences. When students capture images to complement their learning, they harness the power of visual cues to solidify abstract concepts. The act of associating visual representations with theoretical ideas establishes prompts that facilitate recall. As students revisit their photographs, they rekindle the contextual circumstances surrounding the image, effectively triggering memories of related information. For example, revisiting a photo of the Zambezi river in northern Namibia can help to recall some of the various species that are associated with this ecosystem (Figure 1). This process reinforces the neural pathways associated with the subject matter, making retrieval more accessible and robust (Fawns 2023). The act of reviewing images transforms passive memorization into active engagement, as students draw on their visual archives to reconstruct learned concepts. By integrating visual stimuli into the learning process, photography taps into the brain's natural inclination to retain and retrieve information through visual cues, cultivating a stronger and more enduring grasp of educational content.

Photography serves as a tool for sharpening students' observational skills, encouraging them to perceive the world around them with heightened acuity and discernment (Lommen 2012) presenting a pedagogical approach to transformative sustainability education (Yang et al. 2021). Sharpening observational skills also means learning that first impressions can be deceiving. When looking at a large flock of greylag geese (*Anser anser*), an observer may be tempted to conclude that they are exclusively representatives of one species, especially since the calls typical of the species were heard. Only closer inspection reveals that representatives of another species are also part of this observation (Figure 2). When students pick up a camera, they engage in deliberate observation, where every photograph requires careful consideration of the photographed elements. This process prompts students to consider their environment with a discerning eye, training them to notice small details and patterns that might have otherwise escaped their attention. Through the lens, students immerse themselves in their environment, cultivating an ability to perceive nuances and subtleties that contribute to a more comprehensive understanding of the world. This honed observational skill extends beyond photography, enriching their capacity to engage with academic subjects and everyday experiences with heightened sensitivity and depth.



Figure 1. A photo of a sunset at the Zambezi river in northern Namibia (left) triggers the photographer's memories of associated species, such as the pied kingfisher (*Ceryle rudis*; right). Photos: Thomas Göttert



Figure 2. Sharpening observational skills: closer inspection reveals that two Canadian geese (*Branta canadensis*) are part of a large flock of greylag geese (*Anser anser*). Photo: Thomas Göttert

2 Methods & approach

Positively encouraged by an overwhelming interest from colleagues of various disciplines in our discussion paper on the importance of photography for research and education (Currie & Göttert 2023), we have conceptually designed this present discussion paper as a continuation of our discourse, this

time primarily focusing in on a student perspective. The aim was to reflect together with students on the value and benefits of photography in learning.

Our approach to the development of this paper is rooted in Grounded Theory (Glaser & Strauss 1967, Creswell 1998), a well-established research methodology that emphasizes the development of theories and explanations based on empirical data rather than a priori hypotheses or frameworks. Grounded Theory provides a systematic framework for understanding complex phenomena by allowing theories to emerge organically from the data, in this case the student reflections were seen as the “data” on which topics emerged. Although we do not see the student co-author reflections in this discussion paper as data per se, we used a Grounded Theory approach to determine the structure of this paper.

To formulate this paper, we embarked on a journey that commenced with the collection of student reflections on the role of photography in the learning process. These reflections, rich in diverse perspectives and experiences, served as the primary discussion content. It is essential to underscore that our collection of student reflections was intentionally devoid of any preconceived theoretical framework or predetermined hypotheses. Rather we were guided by the student reflections and build on the students’ perceptions in a preferably unbiased manner. This absence of preconceived notions allowed us to embrace the core principle of Grounded Theory: the capacity for theories to be “grounded” in the data itself, permitting fresh insights and novel understandings to surface during analysis. Thus, the content of this paper was largely dependent and guided by what we learned from the students and later enriched with our own educator observations.

In line with Grounded Theory’s fundamental tenets, the collected student reflections were subjected to coding wherein the student reflections were systematically deconstructed into smaller, meaningful units, and codes were assigned to these units. This initial phase was marked by an open-minded exploration, ensuring that we remained receptive to emergent ideas and themes.

In the following sections, we will detail our approach, the subsequent stages of coding, and the structural development of the paper, providing an understanding of how our Grounded Theory approach has guided the formulation of this discussion.

2.1 Identifying student co-authors

The first step was to identify student co-authors. We used purposeful sampling to do this, meaning we identified students who we learned had a certain affinity for photography. Some of the students were known to us, some were recommended to us by colleagues who noticed that the students took photos on excursions, for example. Other students presented their own photos in lectures during their studies and thus identified themselves as interested amateur photographers. We also used a snowballing technique asking the identified student for referrals to other students they felt might be interested in collaborating in the paper. Through this process, six students expressed a willingness and commitment to participate as co-authors. Three students from the Global South in South Africa, and three from the Global North in Germany.

While the purposeful selection process for identifying student co-authors was instrumental in assembling a group of individuals with a genuine passion for photography, it is essential to acknowledge the

inherent biases associated with this approach. The primary limitation in our approach lies in its lack of consideration for racial and ethnic diversity among the selected co-authors. Our process primarily relied on recommendations and self-identification within existing networks, potentially leading to an underrepresentation of diverse perspectives. Furthermore, while a fair gender ratio was achieved, gender bias is another aspect that necessitates recognition. Although the gender balance was maintained, it is crucial to remain vigilant in addressing gender disparities and ensuring equitable opportunities in all phases of research collaboration.

In addition to the acknowledged biases, it's important to note that our co-authors were not selected based on obtaining a representative sample from various academic disciplines either. Instead, they predominantly came from similar fields within the environmental sciences, such as nature conservation, ecosystem management, and resource management MSc and BSc courses. This focus on a specific academic domain introduces a disciplinary bias, potentially limiting the range of perspectives and expertise available for a comprehensive exploration of the topic. We recognize the need to diversify co-author representation across different disciplines to enrich the discourse and provide a more multidisciplinary approach to our investigations.

2.2 Approaching co-authors

Initially, we spoke to the students personally, we briefly described the project, and asked whether they would be interested in working together with us on the project. After obtaining this verbal interest, we sent the students an email in which we directed them to our first discussion paper (Currie & Götttert 2023) to provide our co-authors with context, and to introduce them to the discussion taking place. The project was also explained in more detail. The text of this email can be found in the appendix of this paper (see section 8).

We asked our co-authors to provide us with at least one page of text and a maximum of three photos illustrating their reflections. To bound the discussion in a particular context, being education and learning, we formulated prompting questions as an aide - it was up to our co-authors to decide which of the prompts they wanted to answer, if any at all, and they also had the opportunity to provide further information or address things we did not ask for. With the rather general prompts, we wanted to inspire the students and make it easier for them to reflect and write down their thoughts and experiences. The student co-authors were given three weeks to submit their contributions to the paper.

The prompting questions were initially employed to establish a shared context for the student co-authors to ground their reflections in the discussion. However, we recognized that by formulating these prompts, we were inadvertently guiding the direction of the discussion and imposing a level of pre-structuring that we aimed to minimize. Despite this inherent pre-structuring, we conscientiously crafted open-ended prompting questions to allow students the opportunity to reflect on aspects that might not have been anticipated, thereby creating room for emergent topics to surface.

2.3 Grounded themes and categories

In the next step, our co-author contributions were received and the content within was coded. Since there were only six co-author contributions the text was manually coded by B. Currie and no software

was used. In the initial stage of data analysis, open coding was undertaken. This involved systematically breaking down the narrative into smaller, discrete parts and assigning labels or codes to these parts. We remained open to new ideas and concepts that may emerge during this process. Once open coding was complete, axial coding was applied. This involves examining the relationships between the various codes and identifying common themes, patterns, and categories within. The process continued until saturation was reached, meaning that no new insights, categories, or relationships emerging from the narratives. Throughout the coding process we engaged in constant comparison refining categories and concepts continually. This iterative process helped to develop a more coherent structure for the paper. These themes, patterns and categories became the skeleton or structure of concepts on which the discussions in this paper would hang. At this point, we felt we had developed a structure that was well-grounded in the collected narratives. The following main themes emerged:

- **Learning** – The learning theme grouped narratives that referred to promoting or fostering learning and inquiry, using photography to help with understanding concept or processes and especially in relation to complex or abstract concepts and change over time. This theme also included narratives that referred to photography enhancing more meaningful engagement with concepts and topics. We included references to the use of photography in research and monitoring. Some unexpected topics also included in this theme was how photography can make visible the unseen and inaccessible and how photography is used in developing study and learning materials, and in the preparation for exams.
- **Skills development** – Here we included narratives referring to photography improving knowledge retention and recall, developing observational skills and the development of critical thinking and creativity.
- **Communication** – Under the theme of communication, we grouped narratives describing how photography was used as a medium to communicate concepts and stories and to document and report on experiences. Narratives of photography inspiring or motivating others were also included in this theme.
- **Personal development** – This theme was unexpected and included narratives referring to the fun, entertainment and joy, and the resultant stress relief that comes with photography. It also includes narratives related to photography as a means of self-motivation and inspiration. Furthermore, statements referring to photography helping to build confidence or experience a sense of accomplishment were included. There were also narratives describing how photography helped with deeper introspection, self-growth, and personal development, or helped the co-author live in the moment, or be more mindful. Lastly, narratives describing how the co-authors found photography a useful means to prepare for the unknown and uncertainty were included.

Further to the above-mentioned themes, co-authors also discussed limitations and challenges related to photography, including ethical issues, and provided advice to educators on integrating photography in their work. Lastly, the draft paper was sent to the students for additional input or required edits to ensure that the student co-authors had an opportunity to review and edit how their reflections

were incorporated into the discussion paper and to influence the final outcome. The student co-authors were given two weeks to review the draft paper and provide the lead authors with written feedback. A further opportunity was afforded the co-authors in a virtual feedback meeting where the students were given the opportunity to provide oral feedback and to meet one another for the first time.

3 Student perspectives on photography in education and personal development

Here our co-authors provided their anecdotes and insights from their own journeys with photography. All six students mentioned the categories “learning”, “skills development” and “communicating”. Therefore, we provided each co-authors main points for these three categories independently. When it came to the other categories, we deviated from this format and presented co-author reflections collectively. We have purposefully distinguished our co-author writing to clearly show and emphasize the student perspective in this discussion piece.

3.1 Learning

In this section, we delve into the impact of photography on education and learning. Through a series of self-written narratives, our co-authors Enya, Oliver, Michael, Laura, Valentin, and Yasmin collectively illuminate the transformative potential of photography in their educational journeys. They share their unique experiences, highlighting the ways in which photography has become an indispensable tool for promoting learning, enhancing comprehension, and deepening their connection with the subjects they study. These narratives underscore the versatility of photography, transcending mere image-capturing to become a potent instrument for learning.

3.1.1 *Enya’s learning journey with photography*

“Photography has been integral to my education for as long as I can remember, it has contributed to my learning over the years. As a child we never had TV, but my parents, like those of many nature enthusiasts today, had a subscription to National Geographic. I clearly remember each edition arriving in the post and being dumped on the dining room table, where I would eagerly open it up to page through all the stunning photos, without reading much of the text. I was enthralled to see how the rest of the world looked; the fact that cities could be covered in marble, or have buildings that were thousands of years old; the weird and wacky-looking animals that were considered normal in other parts of the world, and old photos from previous editions that told incredible stories of how things used to be, and how we got to the current state of affairs. I didn’t need to read the magazine to know what it was talking about - photographs are often self-explanatory if taken well, and the photographers at National Geographic certainly know how to take a good one. Sometimes I would see a wonderful photo of a thing or a place that I already knew and suddenly value it so much more, now that someone else had found a way to capture its essence. Insects are a case in point: I did not appreciate their beauty until I saw an edition with macroscopic photos of their exquisite colours and sweet little faces, and to this day I love crouching down to see what they really look like.”

As a youngster, it was easy for me to read about something and imagine the way it looked. However, the imagined version never quite matched reality. I soon realized that when I am learning about complex and foreign things, it is often easier for me to properly understand them if I can find a picture. As they say: “a picture says a thousand words”; and it doesn’t have a language attached to it, so it can say those things to anyone. Photographs have also helped me to properly grasp concepts that I would never fully comprehend otherwise, such as the scale of mining damage to ecosystems, or the extent of deforestation.

I remember the first time I stepped foot in Europe, coming to terms with how different everything is in a first-world country. I think I would have frozen in uncertainty; had I not been prepared for the fact that things could be this different due to the photos that I had seen¹. Of course, I had no idea to what extent things in the first world were different and could only really get my head around it after I got there. Nevertheless, having an inkling of what I could expect helped me to be present and appreciate what I was seeing so much more, and allowed me to better engage with things that fascinate me, such as the politics of Graffiti. I enjoyed seeing the walls of Venice full of messages and pictures from those who had a gripe, and it helped me to realize that the First World has as many problems as we do, and that, there too, people feel cornered by politics.

I have also enjoyed that photography allows one to engage meaningfully with an experience long after the fact. A photo (Figure 3) I took of an orange-breasted sunbird on a hike was left in my downloads folder for a long time. I took it thinking “That’s a pretty birdie, I wonder what his name is”, and was able to answer that question months later, when I took some time to look at memories from that walk. I found out that it is highly endemic, occurring only in the Fynbos, and is also the only member of its genus. Not an education I needed, but certainly one that I was glad to receive!

In the text, Enya reflects on her lifelong journey with photography, emphasizing how the visual medium has been integral to her education. Photography sparked her curiosity about diverse cultures, landscapes, and wildlife. She points out that photographs, when well-taken, are often self-explanatory, serving as a powerful tool to help comprehend complex and foreign subjects, bridging the gap between imagination and reality. She also highlights the role of photography in cultural preparation, as it provided her with a visual understanding of the differences between her home and Global North countries when she travelled to Europe, allowing her to engage more meaningfully with local politics and culture.

She emphasizes how photography isn’t just about capturing moments but also about continuous improvement, experimentation, and discovery. Additionally, she illustrates how photographs serve as lasting memories, enabling her to revisit and learn from past experiences. Finally, Enya suggests that photography can play a role in environmental education and conservation by documenting the beauty and fragility of the natural world, potentially inspiring others to protect it. In summary, she underscores the multifaceted ways in which photography has enriched her life, education, and understanding of the world, both as a child and throughout her adult years.

¹ Repetitive text, co-author reflection also used in section: 3.4.2



Figure 3. Orange-breasted sunbird (*Anthobaphes violacea*); photo: Enya Munting

Enya's reflections hold significance as they illustrate the impact that photography can have on an individual's education. Her journey with photography showcases how this visual medium can spark curiosity, bridge cultural gaps, and provide a tangible means of understanding complex subjects. It highlights the versatility of photography as a tool for learning, whether in comprehending foreign cultures or addressing environmental issues. Her insights shed light on the potential for photography to contribute to environmental education and conservation by inspiring others to protect the natural world. Enya's reflections, therefore, underscore the diverse and holistic ways in which photography can enrich one's life and play a pivotal role in education.

3.1.2 Oliver's learning journey with photography

*"Photography has been my main hobby for about three years, it brings me inner peace and pleasantly challenges me cognitively, pushing me to constantly improve, experiment, and discover. In order to capture a particular species or situation, I first research the habitat conditions required for a particular species to be found in an area. Subsequently, I then study their behaviour, calls, and foraging habits to look for possible signs of their presence in the area. This approach gives me a wealth of information about the biological and ecological aspects of a species even before I even take a photograph. But sometimes, the most interesting motifs can be found in the city as in Figure 4, where a juvenile jackdaw (*Corvus monedula*) was begging for food directly on the street between the after-work traffic.*



Figure 4. Juvenile Eurasian jackdaw (*Corvus monedula*) begging for food; photo: Oliver Rolfes

Furthermore, I extensively explore the regions where these species are located and why they are present there. This enables me to gain a broad understanding of the ecological factors of the area and the relationships between species and their environment during my spare time. Photography led to a deeper connection and identification with the subject. Also, sometimes I have to take new photos to illustrate certain aspects or behaviours discussed in a presentation so that I can observe and internalize the details in nature without feeling this as an additional learning burden. Sometimes, it also helps me, to determine a species I didn't know before, like in Figure 5. Only because of the picture, I was able to determine the species which I haven't seen before and won't forget it now for the rest of my time."

Oliver expresses how photography has become his main hobby, cognitively challenging him. He describes his systematic approach to wildlife photography, which involves research and understanding of the species and their environment before capturing images. This information forms the foundation for his photographic efforts, it not only aids in locating the subjects but also provides valuable insights into the biological and ecological aspects of the species. Additionally, Oliver emphasizes that this approach goes beyond photography, enabling him to develop a comprehensive understanding of the relationships between species and their environment. The author's approach to wildlife photography is grounded in research, ecological understanding, and a deep commitment to capturing meaningful images of the natural world.



Figure 5. A white-backed woodpecker (*Dendrocopos leucotos*) defends its tree against another, a photograph which helped Oliver learn about a species he never knew about before. Photo: Oliver Rolfes

Oliver’s reflections on his systematic approach highlights the educational value of photography, particularly in the realm of ecological understanding and conservation. By conducting research and gaining insights into the species and their environment, Oliver not only captures visually appealing images but also contributes to a broader understanding of the biological and ecological aspects of a subject and the identification of species.

Oliver’s approach lies in the integration of photography with scientific knowledge. His systematic approach underscores the educational and conservation potential of photography, highlighting its role in enhancing our understanding of the natural world.

3.1.3 Michael’s learning journey with photography

“I can recall many times in which photographs have helped better my understanding of scientific concepts and subjects, specifically when dealing with concepts in geomorphology, soil science, animal behaviour, plant studies and even urban geography. For example, when dealing with land formations, you can hear the words ‘ruware’, ‘oxbow lake’, and ‘stream capture’, and you can read the definitions, but when you see what these things are and what they mean – you never forget it.

Furthermore, in processes in urban geography, one needs photographs over time to be able to fully comprehend a concept. For example, ‘gentrification’ and ‘studentification’. These are both processes of neighbourhood character change. The first, wealthier cohorts displacing poorer groups and the second, neighbourhoods changing to cater specifically for the needs of students. Both concepts you can read about, and you can drive through the suburbs not knowing exactly what you are looking at. However, when you have a look at some photographs taken in these areas a few years apart, you will

know exactly what they mean. One of my assignments during my undergraduate degree at Stellenbosch University was to assess studentification on a neighbourhood in the town of Stellenbosch in the Western Cape of South Africa. This involved looking at historical maps, Google 'street-view', and walking the suburbs taking photographs of specific changes in properties – visually comparing 'what was' with 'what currently is'. These are concepts that must be accompanied by images. Even so in plants. I believe that without photographs of different flowers I would never have grasped the concepts of 'flower structure' or 'floral formulae'.

I have used photography in several project and assignments during my time at university, even more so in the field. These sorts of learning activities are, for the visual learner, very stimulating and have left a long-lasting impression on me.”²

Like Oliver, Michael utilizes photography as a powerful tool for learning and understanding the natural world. Michael’s reflection underscores the transformative power of visual aids, particularly photography, in the educational process. It highlights how photographs not only complement textual descriptions but also enhance the depth of comprehension of complex scientific concepts. Furthermore, his experience demonstrates the practical application of photography in research and assignments, reaffirming its importance as a valuable tool for learning in various academic disciplines. Both Oliver and Michael’s experiences highlight the educational potential of photography as a means to explore, comprehend, and appreciate the natural environment.

3.1.4 Laura’s learning journey with photography

“I use photography as a way to personally connect to the information I try to learn. Therefore, with most of my lectures I keep a word document with the learned information from class, including explanatory pictures and images given in the lecture, and then step by step I replace or add my personal photographs and pictures. This process helps me resonate with the information and is an integral part of my learning process.

Through photography, especially in combination with texts or audio, complex scientific topics become easily accessible to a certain degree. Photography can be the first steps taken in exploring and understanding a new topic. By photographing you connect with your surroundings, by photographing educational content, you connect your individual surrounding with your mind-based textbooks, and information becomes less abstract, findable, and personal.

During zoological and botanical lectures, I learnt anatomy with photographs. For example, Figure 6 showing a species of locust I photographed to add to my zoological lecture notes, especially showing the anatomic features of the locusts.”

² Repetitive text, co-author reflection also used in section: 3.3.3



Figure 6. A locust photographed to show anatomical features to add to zoological lecture notes. Photo: Laura Feldenz

“I learnt to identify the different species and to distinguish them from one another with the help of photographs. I learnt about ecological processes through photographs. For example, seeing the photo-documented process of decay in a series of pictures. Seeing the photographs in lectures helped a lot, as well as going out on my own, finding specimens with the aim of photographing anatomical structures or ecological processes. For example, I remember trying to get my own picture of all the different species. It motivated me to learn about where to find them and how to identify the different species.”

During my landscape-ecology studies, just like with the species and processes which are on a small scale, I learnt about landscape ecology on a large scale. Seeing pictures of different landscapes helped me get a better understanding of landscape shaping processes.

Another time my peers and I took up an offer from a planetarium to use their telescopes to photograph extraordinary sights. I learned a lot about the physical process of lunar eclipses and achieved a better understanding and appreciation by experiencing and documenting it in real life. See Figure 7 taken during a lunar eclipse within the framework of my past study program (physics).”



Figure 7. A photo of a lunar eclipse which helped Laura gain a better understanding of the physical process of lunar eclipses. Photo: Laura Feldenz

“I feel that these instances show how photography, used in lectures, helps me grasp complex information by providing visual examples and explanations. Especially labelled images helped me get a visual idea of things, particularly in an ecological context, where information is often lying within the respective system I’m looking at, whether it’s a whole landscape or an individual species and its anatomy.”

Furthermore, for the purpose of a book (Ciesla & Joachim 2022³), Ulrich Schulz, lecturer at the Hochschule für nachhaltige Entwicklung (HNEE), recaptured an old photograph. I helped with the set up and was part of the photographed people. The old photograph to be recaptured showed students and teachers at the university of sustainable development in the 1950s. The purpose of recapturing the image was to show the societal and local changes over time. For example, the old photograph showed only young male students and old male teachers, all wearing uniforms. The new, recaptured photograph showed people of different genders, from different places, older, younger, students and teachers, mixed up in various clothing. Here photography gave me a mirror through time while recapturing it, and later when seeing both pictures next to each other allowed me to see a process of change in a societal environment. Photography, especially when being preserved over a longer period of time, helps one get a visual idea of historical points of view. Old, preserved photographs are like windows into past realities and can contribute to learning processes in historical and societal sciences.”

³ Ciesla B, Joachim HF (2022) Akademischer Kahlschlag- die Geschichte der Forstwirtschaftlichen Fakultät in Eberswalde von 1945 bis zur erzwungenen Schließung 1963. Herausgeber: Ulrich Schulz, Verlag BeBra Wissenschaft, Berlin, Germany, 432 pp.

Laura emphasizes the pivotal role of photography in her learning process, highlighting how it aids her understanding of complex information. She also describes a systematic approach to her studies where she creates personalized study materials by incorporating her own photographs into her lecture notes. This process not only helps her connect with the information on a personal level but also enhances comprehension by providing visual context. Laura underscores how visual elements, such as photographs, offer a more concrete understanding of subjects, making even challenging scientific topics accessible and motivating further exploration. Furthermore, Laura provides several specific examples of how photography has benefited her learning in zoological and botanical studies, and in understanding ecological processes, both in the classroom and by seeking out subjects in the field. Additionally, photography allows her to connect theoretical knowledge with real-world observations. She furthermore discusses the use of photography in capturing historical changes, emphasizing how preserved photographs provide a visual window into the past and allow us to compare the then and now in historical and societal sciences. Overall, her experiences demonstrate the transformative power of photography as a tool for learning and understanding diverse subjects, understanding change over time and transcending scales from the small (anatomical features) to the large (landscape features).

3.1.5 Valentin's learning journey with photography

“Since my initial experiences in Australia, photography has evolved into a recreational passion of mine. I invested in a full-frame camera equipped with a telephoto lens and embarked on vacations where I could photograph captivating species. This hobby has encouraged me to scrutinize nature more closely and has facilitated continuous learning during my travels.

*Currently, I am pursuing a degree in nature conservation at Eberswalde. During the last semester, I was tasked with delivering a presentation on the European adder (*Vipera berus*). Shortly before this assignment, I came across information about adders near Berlin. Consequently, I resolved to photograph wild adders and incorporate them into my presentation. This endeavour compelled me to delve into the subject at a much deeper level. To locate them, I had to thoroughly comprehend the behaviour and requirements of adders. Following numerous attempts, I finally had a memorable encounter with a melanistic female *Vipera berus* (see Figure 7). Discovering an animal I had been seeking out for several weeks was an immensely satisfying experience.”*



Figure 8. A photograph of a melanistic European adder (*Vipera berus*) which marked a memorable and satisfying experience for Valentin. Photo: Valentin Backa

“I also undertook an internship at a reptile conservation centre in Brandenburg. Photography plays a significant role here. In projects involving the reintroduction of endangered reptiles, regular monitoring is conducted using cameras to observe the development of populations. Furthermore, photographs of these animals are taken to educate the public about them, and to inspire future generations to advocate for the protection of these species.

In retrospect, photography and the resulting visualization of animals and habitats have significantly contributed to my knowledge expansion. The deliberate engagement in actively seeking and capturing photographs has solidified and internalized my understanding. Furthermore, it provides a hands-on experience.”

Valentin describes how photography has evolved from a casual interest to a passionate hobby that has deepened his connection with nature and facilitated ongoing learning by fostering a closer scrutiny of nature. This passion for photography became particularly instrumental during his studies in nature conservation, where he undertook the challenge of photographing wild European adders for a presentation. This endeavour pushed him to develop a deeper understanding of the behaviour and habitat requirements of the adders, resulting in a rewarding encounter. Additionally, he discusses his internship at a reptile conservation centre, emphasizing how photography plays a crucial role in monitoring endangered reptile populations and in educating the public. Overall, Valentin highlights how photography has not only expanded his knowledge but also provided hands-on experiences in wildlife conservation and research.

3.1.6 Yasmin's learning journey with photography

“Some instances where photography and images have helped me learn new things have been with animal diseases. Although sometimes quite gruesome, images of symptoms shown on animals from diseases have helped me understand the effect it has on the animal. In my practical year we performed an autopsy on a juvenile elephant that looked perfectly healthy on the outside. Once we opened the elephant’s abdominal cavity the vet quickly realized why it had died. The elephant had ascites, a condition where there is excessive fluid build-up in the abdomen. How do you explain the severity of this condition to a person without an image?”

In university we learned of mimicry, when an animal mimics the appearance of another animal to avoid predation. An example of this is how cheetah cubs resemble honey badgers. We also learned that scorpions glow under florescent light. These are both difficult concepts to understand until you put an image of a cheetah cub and a honey badger side by side, and see a picture of a scorpion under a florescent light (Figure 9).”



Figure 9. Scorpion under a florescent light; photo: Yasmin Markides

Yasmin emphasizes the educational power of images and photography, particularly in understanding complex topics like animal diseases and biological concepts. The examples she provides illustrate how visual aids, in the form of photographs and images, enhance understanding and made abstract or intricate concepts more accessible to her, this includes making the unseen seen, such as the scorpion under a florescent light. Yasmin underscores the effectiveness of visual aids, such as photographs and images, in enhancing the understanding of complex topics. Visual learning can be especially beneficial for students who may struggle with purely textual or abstract explanations. It provides a different mode of comprehension and appeals to a variety of learning styles.

Yasmin's example of the scorpion seen under fluorescent light illustrates how photography can bridge the gap between the seen and the unseen. It brings to light hidden or intricate aspects of the natural world that might otherwise remain elusive or challenging to grasp. This aspect of photography is of value for scientific education, as it enables students to explore and understand phenomena beyond what is visible to the naked eye. Images and photographs can make educational content more accessible and engaging. They have the power to simplify complex ideas, making learning more approachable and enjoyable. Yasmin's reflections emphasize how visuals can demystify challenging subjects, fostering a sense of curiosity and wonder. By highlighting the role of photography in her own educational journey, Yasmin sheds light on how images can enrich the learning experience. They can make learning more memorable and impactful, aiding in long-term retention of knowledge. Yasmin's insights underline the value of incorporating visual elements, particularly photography, into educational materials. They help make learning more inclusive, engaging, and effective, particularly when dealing with complex scientific or abstract topics. Visual aids like photographs can be valuable tools in promoting understanding.

3.1.7 Distilling the students' perspectives on photography and learning

In these reflections, Enya, Oliver, Michael, Laura, Valentin, and Yasmin all underscore the transformative role of photography in their educational journeys. Enya's lifelong connection with photography has enriched her understanding of diverse cultures, landscapes, and wildlife, turning it into a recreational passion. She highlights the self-explanatory nature of well-captured photographs and their ability to bridge the gap between imagination and reality. Photography also plays a key role in cultural preparation and environmental education for Enya.

Oliver, Valentin and Michael all utilize photography as a tool for learning about the natural world, with a focus on wildlife and plant identification. Oliver's systematic approach to wildlife photography emphasizes research and ecological understanding. Laura, on the other hand, discusses the role of photography in her learning process, creating personalized study materials with images to enhance her comprehension of complex subjects and change over time. Valentin's journey demonstrates how photography deepens the connection with nature and aids in understanding wildlife during studies in nature conservation. Finally, Yasmin discusses the power of images, particularly in understanding topics like animal diseases and biological concepts, emphasizing how visual aids make abstract concepts and the unseen more accessible to learners. For example, see Figure 10 of a stabilimentum on a spider web used in lessons to debate the function of these structures.



Figure 10. Stabilimentum on a spider web; photo: Bianca Currie

These experiences collectively highlight the educational and transformative impact of photography across various fields and contexts. They all share a common perspective on photography as a powerful tool for learning. They recognize that photography goes beyond simply capturing moments; it serves as a means to enhance understanding and facilitate learning in various domains. They acknowledge that photography helps with comprehending complex and foreign subjects more effectively. Whether it's understanding wildlife, ecological processes, diseases, or historical changes, photographs provide visual context that aids in grasping abstract or intricate concepts. For example, see Figure 11 comparing overgrazed vegetation with that of a well-managed landscape.



Figure 11. Comparing well managed veld with overgrazed veld by goats in the arid Karoo environment in South Africa. The image is used to demonstrate the impact goats can have on the arid landscape. Photo: Bianca Currie

Photography has engaged our student co-authors visually and connected them emotionally with the subject matter. They find that photographs capture the essence of the subject and evoke a personal connection, making the learning experience more engaging and memorable. They emphasize that well-taken photographs can vividly represent the subject, allowing us to see and connect with the subject matter in ways that words or descriptions alone cannot achieve. Photography often serves as a source of motivation for learning. Whether it's a hobby, a research project, or academic studies, the act of capturing images motivates them to delve deeper into the subject, conduct research, and seek out new knowledge. They all share an appreciation for the multifaceted role of photography in expanding their knowledge, enhancing their understanding of the world, and fostering a deeper connection with the subjects we study or capture through photography.

3.2 Skills development

Skills development emerges prominently from the diverse reflections of our co-authors, offering insights into the multifaceted ways in which photography has enriched their educational journeys through the development of a range of skills. Our co-authors collectively emphasize the role of photography in skills development, and they share a connection between understanding concepts and the ability to recall knowledge. This intricate interplay of skills is not limited to traditional academic content but extends to the recollection of moods and emotional landscapes, echoing the significance

of photography in a holistic sense. Moreover, it becomes evident that photography plays a fundamental role in honing their observational abilities, their ability for species identification, and even the cultivation of creativity and critical thinking.

3.2.1 The skills Enya developed through photography

“Finding a picture to properly understand complex concepts is a philosophy that I carried right through university and one which I am sure has helped me not only to accurately learn about the natural environment and its conservation, but also to remember what I have learned better. A clear picture of a burnt savannah with a few young trees that managed to escape the fire through their previous year’s growth is etched into my memory and, alongside others, will forever define certain complex ecological concepts. All I needed was to recall that picture in an exam room, and I found myself able to analyse what happened in that ecosystem to a minutia, racking up marks as I remembered the details we discussed in class about why it looks the way it does.

Of course, photos have benefitted my education more directly as well: I often use photos of fish in my Masters’ project to help me identify species, and I took many photos for my undergraduate mini thesis project to help me catalogue plants in the ecotones that I was exploring. These were a valuable resource and allowed me to accurately identify plants long after I had concluded my data collection, or to ask for help from experts when I could not.” See Figure 12, a photo of a Kapok bush (*Eriocephalus microphyllus*) that was used to identify the plant species.



Figure 12. An example of a photo used to identify a plant species, the Kapok bush (*Eriocephalus microphyllus*). Photo: Enya Munting

Enya's reflections underscore the impact of visual learning on her educational journey. Her philosophy of using pictures to grasp complex concepts not only facilitated her understanding of the natural environment and its conservation but also enhanced her ability to retain and recall knowledge. She illustrates how a single image of a burnt savanna with resilient young trees serves as a mental anchor, allowing her to dissect intricate ecological concepts during exams. Beyond theoretical knowledge, Enya highlights the practical utility of photography in her academic pursuits, aiding her in species identification for her Master's project and assisting in plant cataloguing for her undergraduate research. Enya's experiences encapsulate the dual role of photography in education, enhancing comprehension and offering a valuable reference for ongoing research endeavours after the experience.

3.2.2 The skills Oliver developed through photography

“While photographing, I carefully observe the surroundings, evaluate the circumstances, and attempt to apply the knowledge acquired beforehand. In this way, I can link what I have learned with the observations on the ground, thus deepening my knowledge considerably.

I am also fascinated by the aspect of composing visually appealing images. This includes aspects such as colour theory, the effect of different lighting conditions, composition, photo editing and understanding the camera technique, as well as directing human attention to a particular message of the photo.⁴ I then apply this knowledge to photography but also to image editing.

During post-processing, I carefully examine the image, paying attention to the characteristic features of the animal, the specific situation, its behaviour, and the environment in which the scene is set. At the same time, I observe the colours, lighting, and composition. This close observation ensures that the images remain vivid in my memory, so that I can recall them when needed and link them to the ecological background knowledge. In this way, art and knowledge are linked in my memory in a special way. In Figure 13 I wanted to shoot the photo in exactly this way which took a very long time, so I also learned, while shooting, a lot about the mating behaviour of the dragonflies. Afterwards, I edited it in an artistic manner taking all the above points into account. Also, sometimes I had to take new photos to illustrate certain aspects or behaviours discussed in a presentation so that I could observe and internalize these details. The experiences and knowledge that I have gained through photography, I can remember much better than if I had just learned them by heart.”

⁴ Repetitive text, co-author reflection also used in section: 3.3.2



Figure 13. Mating behaviour of common darter (*Sympetrum striolatum*); photo: Oliver Rolfes

Oliver highlights how photography develops his observational skills. Furthermore, he reports on how photography has helped him to develop creativity and critical thinking abilities. Like Enya, Oliver also acknowledged the importance of photography as a tool to recall knowledge linked with images. However, the synergy between art and knowledge within his photography practice is notable. Oliver emphasizes the value of actively engaging with the environment to capture specific aspects or behaviours, making learning a more immersive and memorable experience. This holistic approach to education through photography highlights how the combination of observation, artistry, and real-world application enhances knowledge retention and creates a unique bond between art and learning.

3.2.3 The skills Michael developed through photography

“I have noticed time and time again how visual stimulation improves my knowledge retention. Even if it is just words, I need spider diagrams or mind maps. I need colours and different font types to remember things. But the best way for me to remember things is to think of an image, photo, video or a real-life scenario going on in my brain, and to try articulating that. Concepts like the ‘flehmen response’ in lions (Figure 14), ‘temporal secretions’ in elephants, or a hyena ‘anal pasting’ (Figure 15) for example. Rolling the lip back, wet patches between the ear and eye, or a piece of gum-like substance on the tip of grass strands. It doesn’t mean much at first, however after seeing it you will understand it, once again, you will never forget it.”



Figure 14. Male lion (*Panthera leo*) performing flehmen response; photo: Michael Klaver.

“I also used photos and software to learn, for example learning plants on iNaturalist. When I started working on a game reserve in the Thicket biome in the Eastern Cape of South Africa, I knew only a handful of the plants. Every time I would see new plants, I would take photos and have iNaturalist identify the species for me. This was a great way for me to learn.

My high school geography teacher used to tell me, “the more you know, the more you see”, which does not at first highlight the importance of seeing something, however when understanding the cyclical nature of it through the Visual Communication’s ‘circle dance’ (quoted below) – it makes perfect sense.

*“The more you know, the more you sense.
The more you sense, the more you select.
The more you select, the more you perceive.
The more you perceive, the more you remember.
The more you remember, the more you learn.
The more you learn, the more you know.”*

“To sense is to see clearly. To select is to critically analyse, observe and interrogate a scene. To perceive is to make sense of what you are seeing so that your mind will remember this information over the long term – increasing what you know through expanding your knowledge base. Then you cycle through this process again. However, now you know more, so you will see more. It is exponential growth.



Figure 15. Brown hyaena (*Parahyaena brunnea*) anal pasting on a blade of grass; photo: Michael Klaver

I believe there is value in developing both creativity and critical thinking through photography. Creativity dealing with the ‘sense’ and ‘select’ as mentioned earlier, and critical thinking in the ‘select’ and ‘perceive’. Also, the development in the skill of observation – critical to the scientific mind. I know Allan Savory is quite critical of the new cohort of scientists only believing what they read in peer-reviewed papers, and the lack of the ability to make their own observations and judgements. Photography, and developing the skill of observation, I believe, can fill this gap. After all, we learn through hypothesizing, questioning, testing, observing and then finding – maybe not in that order but it’s the scientific method.”

Michael refers to the importance of knowledge retention via visual cues in general and points out the importance of photography for improving observation skills and species identification - here he explicitly mentions the importance of digital media and tools in connection with photography. He also highlights that the value of photography is not limited to the visual stimulation but stresses its great importance for the development of creativity and critical thinking – an aspect that is mentioned by most other students as well.

3.2.4 The skills Laura developed through photography

“By taking a photograph I am able to refer to the seen image again and again during the learning process. This not only helps me understand and remember based on words, but also by connecting

information to helpful visual elements, which most of the time gives a more complete picture of a situation, a more concrete idea of what I'm trying to understand and remember.

One example was me learning about the alps during lectures, how they evolved, how humans shaped the natural and cultural landscape and then going on vacation, photographing, trying to find the perfect image which resonated with what I had learned, and to add it to my study materials. Therefore, it helped me during a "leisure time" activity to crave understanding and remember the information I learned during lectures.

During my practical semester I did research within a core zone of a protected forest area: In this instance I used photography especially to help me remember, as I had restricted access to my research plots. Photography (especially 360-degree photography) helped to remember the landscapes and specifications.

A further example comes from when I had a student job developing a grass detection app filled with photos of different species and identification specifications. Before this, I knew nothing about grasses, after photographing a serious number of different grasses and their identification structures, I felt pretty confident in detecting several species, and especially felt confident in examining the identification structures (which in most cases was good enough to include in an identification book/field guide).⁵

Photography (especially 360-degree photography) allowed me to express what being in a wild, untouched forest looks like, and especially feels like. In this assignment I was able to remember the places better and it helped me with the ongoing analysis through reporting. I was also able to present to others something generally inaccessible.

Photography allows for longer learning processes through the durability of photographs, which is important for the processes of remembering or recollecting, but also, long term, for showing different versions of reality through time for historical or societal sciences."

Similarly to Michael, Laura's reflections show that understanding concepts and making things conscious through photography are closely linked. Laura gives examples in various places that show the extent to which awareness and memory of imparted specialist knowledge are stimulated by photographs. At the same time, Laura also points out the usefulness of photography for identifying species in taxa that can only be reliably determined by studying difficult characteristics. Furthermore Laura, like Enya mention how photographs extend the learning window of time allowing them to recall and access images after the fact.

3.2.5 The skills Valentin developed through photography

"Since my childhood, I have held a strong fascination for Australian carpet pythons (Figure 16). Due to their intricate and consistently evolving taxonomy, I often struggled with identifying species and subspecies. A few years ago, I journeyed to Australia with the aim of gaining a deeper understanding of the Morelia genus (Carpet pythons). I embarked on capturing them in their natural habitat, and since then, I've been captivated by the world of wildlife photography. These photographs aided me

⁵ Repetitive text, co-author reflection also used in section: 3.4.2

in committing the distinctive features of various species to memory and provided me with my initial glimpse into the advantages of photography.



Figure 16. Carpet python (*Morelia spilota mcdowelli*) from Moreton Island, this photograph brought to light the intricate details of the species for Valentin. Photo: Valentin Backa

The photo I captured of the adder revealed details that I likely wouldn't have noticed otherwise. I observed that these snakes have keeled scales, and it became even more evident to me that they have orange eyes. These snakes have distinctive scales on their heads that can be used to identify each individual. Thus, capturing photographs of these snakes enables us to track the movements of the animals and identify each snake separately. In another example related to birds, capturing a high-quality photograph reveals intricate details and often allows for the determination of the bird's sex. This hobby has encouraged me to scrutinize nature more closely and has facilitated continuous learning during my travels."

Like all other students, Valentin particularly mentions two aspects related to the topic of skills development: one is the improvement of the ability to observe nature and the other is the re-awareness / knowledge retention through looking at photographs. Valentin has a clear focus on the aspect of observing nature and identifying diagnostic characteristics for species identification, e.g. in terms of the critically endangered Siamese crocodile (*Crocodylus siamensis*) in Figure 17.



Figure 17. Siamese crocodile (*Crocodylus siamensis*) from Vietnam revealing diagnostic features of the species; photo: Valentin Backa

3.2.6 The skills Yasmin developed through photography

*“Often, I remember the less important details. This is often the case for species identification for me especially small cryptic species, for example I know that one of the major differences between the large spotted (*Genetta tigrina*) and small spotted genet (*Genetta genetta*) is that one has a white tip on the end of the tail. I can never remember which one has the white tip so reverting back to images helps jog my memory. Overall, I believe that whether a person is a visual learner or not, photography and images can play a major role in knowledge retention especially in the field of conservation.”*

While several other students have pointed out the connection between understanding concepts and recalling knowledge, Yasmin also emphasizes the connection between knowledge documentation and species identification.

3.2.7 Distilling the student’s perspective on photography and skills development

Two aspects were mentioned by all our co-authors. One aspect is the preservation of knowledge and the (re)consciousness of knowledge with the help of photography, and the other is the development of the ability to observe nature, or the ability to identify species (both in a zoological and botanical context). It became clear that these two skills are closely linked to other aspects, particularly the intellectual permeation and better understanding of concepts. Therefore, it is not easy to consider learning and skills development separately. What is particularly interesting is the fact that the knowledge retention is not limited exclusively to classic learning content, which is important with regard to aspects that will be highlighted in the following sections of the discussion paper. Other skills that obviously play an important role, although this was mentioned by fewer than four of the six student co-authors, is the development of creativity and the further development of critical thinking skills.

3.3 Using photography to communicate

In this section of the discussion paper, our co-authors delve into the multifaceted role of photography as a powerful medium for communication within the realm of learning and personal development. The diverse perspectives offered by each co-author shed light on how photography serves as a conduit for sharing and inspiring others. While exploring the interplay between communication and visual learning, they uncover the deeper connections that tie these two elements together, ultimately revealing the ways in which photography contributes to knowledge dissemination and motivation. Each co-author brings a unique viewpoint to the table, and together, they unveil the dynamic relationship between photography, communication, and the enrichment of educational journeys.

3.3.1 *How Enya communicates with photography*

“The multifaceted ways in which photography has contributed to my learning over the years have made it an incredibly important medium of communication to me. I wanted to learn to tell stories through photos too. You need to understand what it is that you are looking at and conceptualize the best photo that you can take, which will convey your message truly to anyone who sees it.”

Enya highlights how photography serves as an essential medium of communication, allowing her to tell stories through images. The significance lies in her aspiration to convey messages and stories effectively through photographs. To achieve this, she recognizes the importance of not just capturing moments but understanding the subject matter and conceptualizing the best approach to create photographs that genuinely convey their intended message to anyone who views them. In this pursuit, photography becomes a powerful tool for visual storytelling and communication, transcending language and reaching a broad audience. The reflection highlights Enya’s commitment to mastering the art of using photography as a means of powerful and universal communication.

3.3.2 *How Oliver communicates with photography*

“I am also fascinated by the aspect of composing visually appealing images. This includes aspects such as colour theory, the effect of different lighting conditions, composition, photo editing and understanding the camera technique, as well as directing human attention to the one particular message of the photo⁶.

For one summer semester, we took a week-long field trip to eastern Poland, which I documented photographically. Many of these images were used in the reports of my fellow students and contributed significantly to the illustration of the various topics. I had the opportunity to use my own photos in presentations which was a great pleasure and led to a deeper connection and identification with the subject.”

Oliver’s focus is on motivating and inspiring others through the communication of content. Oliver draws attention to the fact that the distribution of content also depends on the photographer’s technical and methodological skills, and he adds the aspect of personal connection to a topic, which can be a result of successful communication. Oliver’s fascination with composing visually appealing images speaks to the artistry and technical skill inherent in photography. By delving into aspects such

⁶ Repetitive text, co-author reflection also used in section: 3.2.2

as colour theory, lighting conditions, composition, photo editing, camera technique, and the art of directing attention, he underlines the complexity of the craft.

The significance of his reflection becomes evident when he discusses the practical application of his photography skills during a field trip to eastern Poland. The fact that many of his images were used in his fellow students' reports and presentations demonstrates how photography can be a potent tool for enhancing the visual appeal and illustrative quality of academic and informative content. Furthermore, the pleasure he derives from using his own photos in presentations underscores the personal connection and identification he feels with the subject matter. This highlights how photography not only enriches communication but also forges a deeper connection with the content being conveyed, making it a significant medium for effective and engaging communication.

3.3.3 How Michael communicates with photography

“It is the skill of making observations and interpreting what you see. Visual cues, whether they are still images or video, are important for conveying “big ideas”. I think it would be impossible to learn some processes in geomorphology or physical geography without visual examples. This is probably why textbooks used in Geography are the most exciting ones you will find. They are full of images! And I still go back to them almost a decade later to relearn, teach or find concepts which I am currently dealing with to get a visual explanation. These sorts of learning activities are, for the visual learner, very stimulating and have left a long-lasting impression on me.⁷ Even out of my own I like to use a lot of images to bring across my message – sometimes just to entertain and keep the reader interested.

My philosophy behind capturing these images is to make these wild places attractive, exciting and interesting so that others would want to experience that too. Whether it’s a herd of wildebeest walking down a dust-filled riverbed or a lion staring you dead in the eyes (see Figure 18). My goal is to entice my city-dwelling friends, showing that there’s more to life than what you are currently experiencing.”

⁷ Repetitive text, co-author reflection also used in section: 3.1.3



Figure 18. Lion staring you dead in the eyes; photo: Michael Klaver

Similar to Oliver, Michael also attaches great importance to the fact that photography is, on the one hand, a communication medium in the sense of learning processes and, at the same time, an important tool for motivating others. With Michael, the connection between communication and visual learning is particularly obvious and highlighted.

Michael's reflection underscores the significance of photography in communication, particularly in the context of conveying complex ideas and concepts. His emphasis is on the importance of visual cues, whether in the form of still images or video, serving as a compelling testament to the power of visual communication. He highlights how photography is an indispensable tool for comprehending processes in disciplines like geomorphology or physical geography. The observation and interpretation skills associated with visual learning are essential for conveying substantial and intricate concepts effectively.

Furthermore, Michael's recognition of the visual richness in geography textbooks and their enduring value as reference materials reinforces the idea that photography plays a vital role in education. The significance of his reflection is in his use of images in his own communication. Whether for educational or entertainment purposes, the use of images enriches the message and maintains reader engagement. Lastly, Michael's philosophy behind capturing these images—making wild places attractive, exciting, and interesting—serves as a reminder of the compelling role of photography in inspiring others to explore and connect with nature. His goal of enticing city-dwelling friends to experience the world beyond their immediate surroundings illustrates how photography can be a catalyst for broadening horizons and promoting a connection with the natural world.

3.3.4 How Laura communicates with photography

"I developed a photography-based virtual reality tour to understand and then present ecosystem functions of the Grumsin Forest, including the administrative structure of being in a biosphere reserve, while still being a UNESCO World Heritage Site. Photography (especially 360-degree photography) allowed me to express what being in a wild, untouched forest looks and especially feels like.

I also developed a photography-based app to capture an excursion as part of my examinations. I used it to present learned information, the excursion structure, and the overall feelings associated with the respective places and topics. This photo-based approach enabled me to express my insights in a much deeper way, helping my peers and lecturer to visualize my experiences and insights and through the app, to experience it in a self-determined and interactive way. To explain, we visited a peat depletion area and then we visited a renatured landscape 40 years after peat extraction. The user of the photo-based application was able to interact with the images. A slider was provided to transition from one image to the next converting the image from a before and after perspective. With this I was able to transport a feeling I felt seeing this extraordinary transformation from brown desert to lush swamp. I included information about the process of renaturation and therefore transported the learned information together with the emotion, the feeling, and the visual aspects I was presented with in real life. This transported the idea much better than just written text.

The same happened with two pictures of a salt meadow landscape, where I took pictures before and after flooding. I then included pictures and info boxes about the different species, which claim the landscape at different water levels: from the salt meadow plants and "Schlickkrebse" (mud crabs)

you can only hear in low tide, to sea hounds roaming the landscape when it's flooded. By allowing the user to interactively morph through my photographs I was able to transport this remarkable change of landscape and habitat much more intensely than by just describing it.

Photography allows longer learning processes through the durability of photographs and is important in the process of remembering or recollecting, but also, for showing different versions of reality through time for historical or societal sciences. Photography can also inspire, I just experienced the power of photography and images in the natural history museum in London, where a special exhibition focusing on images connected to science was displayed. Museums, like in this example, but also other institutions dedicated to education, can make use of photography to inspire and excite people about important scientific matters. By photographing complex scientific topics, especially in combination with texts or audios, they become easily accessible to a certain degree. This effect can be used when communicating to non-scientific public, but also in education and scientific lectures to introduce in a new topic in an inspiring way."

Laura's development of a photography-based virtual reality tour to understand and present ecosystem functions in the Grumsin Forest illustrates how visual elements can provide a deep and immersive understanding of complex subjects. By utilizing 360-degree photography, Laura successfully conveys the essence of being in a wild, untouched forest, allowing viewers to not only see but also feel the environment, thus demonstrating how photography can help transfer feelings and emotions to others.

Furthermore, her creation of a photography-based app for an excursion demonstrates how images can be used to present learned information and experiences in a comprehensive and engaging way. By incorporating features that enable users to interact with images, including before-and-after perspectives, she effectively transports the emotional and experiential aspects. This approach goes beyond written text and brings to life the transformations and natural processes in a tangible manner.

The significance of Laura's reflection extends to the broader role of photography in education and science. She emphasizes the role of photography in facilitating longer learning processes through the durability of images and highlights its importance in remembering and recollecting information. Furthermore, her mention of the natural history museum in London and its focus on images connected to science underscores how photography can inspire and excite people about important scientific matters. Laura's reflection underscores the power of photography in making complex scientific topics accessible, inspiring learners, and enhancing the educational experience.

3.3.5 How Valentin communicates with photography

"During my last semester, I was tasked with delivering a presentation on the European adder (Vipera berus). Shortly before this assignment, I came across information about adders near Berlin. Consequently, I resolved to photograph wild adders and incorporate them into my presentation. This endeavour compelled me to delve into the subject at a much deeper level. Since I was in an area inhabited by adders, I was able to capture photos of their habitat. This allowed me to convey the ecological requirements of adders much more effectively. I didn't have to rely solely on descriptions of their habitat; instead, I could show it first-hand, providing a much clearer and vivid impression. Furthermore,

photographs of these animals are used to educate the public about them and to inspire future generations to advocate for the protection of these species.”

Valentin’s remarks, emphasize the importance of photos as a communication tool for increasing substantiation and credibility of content. This is an interesting addition to Michael and Enya’s comments who emphasized that the technical aspects also influence the significance of the effect of photos. Moreover, Valentin emphasizes that one’s own photos can help to convey the content more credibly. Like all other students, Valentin also points out the importance of photos as a means of communication arising from the fact that they have an inspiring effect on others.

Valentin’s reflection highlights the significant role of photography in enhancing communication, particularly in the context of nature conservation and education. His experience of incorporating wild adder photographs into a presentation on the European adder demonstrates the power of visual elements in deepening the understanding of ecological subjects. By capturing photos of the adders’ habitat, he effectively conveys their ecological requirements, providing a tangible and vivid impression that goes beyond textual descriptions. This approach enriches the educational experience by allowing the audience to visually explore the natural environment of the species.

Moreover, Valentin’s mention of using photographs to educate the public about these animals and inspire future generations to advocate for their protection underscores the broader impact of photography in conservation efforts. Images serve as a powerful tool for raising awareness and fostering a connection between the audience and the subjects, motivating them to become advocates for the protection of these species. In this way, Valentin’s reflection emphasizes the multifaceted role of photography in communication, from enhancing understanding to inspiring action in the realm of conservation and education.

3.3.6 How Yasmin communicates with photography

“I really enjoy using photography and images to convey a message or explain a situation or event to someone. For example, when writing up my final project for my practical year working in Addo Elephant National Park I used several images to further elaborate on my explanation of the activities I undertook on a daily basis, like cleaning a water pump diesel engine and notching a rhino’s ears (Figure 19). By using images, I was able to give the experts a visual representation of the different conditions and this made it easy for them to describe the condition of the rhino in detail.

Using photos has also helped me explain to people how steep some of the hills were that I had to climb to do fence patrols, and how big a fully grown male lions’ paw actually is (Figure 20).”



Figure 19. Black rhino (*Dicerus bicornis*) with surgical clamps on its ears – ear notching allows later individual identification; photo: Yasmin Markides



Figure 20. Photograph of a lion paw in relation to a human hand to illustrate the size of the paw; photo Yasmin Markides

The co-author's reflections emphasize the practical and impactful role of photography in communication. By using images to convey messages and explanations, Yasmin enhances her understanding of complex situations and activities. In her practical work at Addo Elephant National Park, photography serves as a valuable tool to complement her descriptions of daily tasks and challenges. For

instance, it aids in presenting the conditions of rhinos and steep terrain during fence patrols. Additionally, the co-author utilizes photographs to provide visual references, allowing her to effectively convey the size of a fully grown male lion's paw. The significance lies in the ability of photography to bridge gaps in understanding, making complex concepts more accessible and aiding experts in detailed assessments. It underscores how visual elements can enhance communication and facilitate a deeper grasp of the subject matter, particularly in fields where hands-on experiences are challenging to convey through text alone. For example, see Figure 21 showing students undertaking vegetation transects during a field trip to Carlitzdorp in South Africa. This photograph helped to document the experience and method used in the field and served as a reminder for the students.



Figure 21. Students undertaking vegetation transects during a field trip to Carlitzdorp in South Africa; photo: Bianca Currie.

3.3.7 Using photography for documentation

Here, we delve into the role of photography as a means of documenting and preserving experiences in the realm of education and personal development. Our co-authors share a few insights on how they have harnessed the visual medium to chronicle their journeys, whether it be capturing the intricate facets of the natural world, preserving historical and societal changes, or immersing themselves in the visual storytelling of their educational endeavours. Through their reflections, we uncover the ways in which photography not only captures moments but also encapsulates the essence of their learning, fostering a deeper connection between personal experiences and the knowledge they have acquired.

Table 1. Statements about photography for documentation purposes

Co-author	Reflection on using photography for documentation purposes
Enya	<i>“I realized that running away to a “perfect world” will never be an option, for anyone. Photography allowed me to share this with others back home.”</i>
Oliver	<i>“Photography offers a unique opportunity to document situations in a way that no other medium can.”</i>
Michael	<i>“I grew up in a family passionate for travelling locally. My parents would document everything – in those days on film. But as I got older it was now my turn to capture these experiences and memories.</i> <i>My final report for my Nature Conservation undergrad was a lengthy report of 90 pages discussing what I had been doing and learnt during my ‘work-integrated learning’. I had 75 figures spread over the report – almost one a page. It might not have necessarily been the integration of figures into my report, but I received a good response to that.”</i>
Laura	<i>“Through visiting the forest, documenting, and photographing different places and respective structures within the forest I learned a lot about the individual specifications of the forest and its management. Presenting this afterwards was a great opportunity to think about how to share my new learned information with peers and others.</i> <i>I developed a photography-based app to capture an excursion (this was part of my examinations): I used it to present learned information, the excursion structure, and the overall feelings associated with the respective places and topics.”</i>
Yasmin	<i>“Not many people get to experience these situations so showing someone a photo of a rhino with surgical clamps on its ears would be pretty confusing unless you explain to them why they are there.”</i>

3.3.8 Distilling the student perspectives on photography and communicating

The student reflections collectively underscore the role of photography in enhancing communication, with a particular emphasis on education, conservation, and inspiring action. Whether it's utilizing images to convey complex ecological concepts, to deepen the understanding of natural processes, or to inspire future generations to protect wildlife, photography emerges as a multifaceted tool for creating connections and conveying messages. Each reflection highlights the transformative power of visual elements in education, science, and public engagement, emphasizing the lasting impact that well-captured images can have in fostering a deeper appreciation for the natural world and inspiring positive change.

The co-author reflections on using photography for documenting experiences underscore the transformative power of visual storytelling. Enya's realization about the imperfection of a "perfect world" and her use of photography to share this insight highlights how images can convey nuanced messages and perspectives, bridging the gap between different realities. Michael's family tradition of documenting their travels on film demonstrates the role of photography in preserving and passing down memories through generations, connecting the past and present. Oliver's acknowledgment of photography's unique ability to document situations emphasizes its capacity to capture moments and convey the essence of a particular time and place. Furthermore, Michael's experience of incorporating 75 figures into his lengthy report not only highlights the effective integration of images but also emphasizes the positive response received, underscoring how visual elements enhance the comprehension and engagement of the audience. One such story could be the tendency toward flight behaviour in a red-backed shrike (*Lanius collurio*) (Figure 22).



Figure 22. A tendency towards flight behaviour of a red-backed shrike male (*Lanius collurio*) teaches the photographer to seize the moment. Photos: Thomas Göttert

Laura's reflection on how documenting and photographing the forest led to a deeper understanding of its complexities illustrates how photography can be a tool for self-reflection and knowledge sharing. Yasmin's mention of a photograph of a black rhino with surgical clamps on its ears exemplifies how photographs can serve as visual records that require context and explanation, emphasizing the need for storytelling alongside image documentation. These reflections collectively highlight photography's capacity to document and communicate personal experiences, memories, emotions, perspectives, and even methods, offering a visual language for sharing the richness of life's journeys and the lessons learned along the way. For example, Figure 23 captured during a student field trip elicits memories of the trip years later.



Figure 23. Photograph taken during a student field trip used as a reminder of the experience years later; photo: Bianca Currie

Laura's insights also extend the significance of photography in documentation to various scientific disciplines, emphasizing the importance of connecting theoretical knowledge to real-life experiences and observations. Whether in history, archaeology, or societal themes, the capacity to visit, photograph, and document real-world situations, places, and artifacts becomes a fundamental aspect of research and learning. These reflections collectively underscore how photography serves as a useful tool for conveying the richness of experiences, linking theory with reality, and enhancing communication across diverse academic fields.

3.4 Personal development

In the co-author reflections, the multifaceted impact of photography on personal development comes to light as an unexpected central theme. These reflections illuminate the diverse ways in which photography catalyses personal growth, self-motivation, and self-discovery. Through the lens of their experiences, the co-authors unveil how photography serves not only as a tool for capturing moments but also as a source of joy, entertainment, and stress relief, anchoring them in the present moment. Moreover, photography emerges as a medium for stimulating feelings of accomplishment, building confidence, and supporting a deeper understanding of oneself. The interplay between visual storytelling, mindfulness, and preparation for the unknown underscores the role of photography in broadening horizons and nurturing personal development. This section delves into these themes, featuring the co-authors' perspectives on how photography has enriched their lives and contributed to their personal growth.

3.4.1 Self-motivation

Photography, often regarded as a medium for capturing moments, reveals itself as a powerful tool for personal development and encouragement. These reflections collectively underscore how images not only record the world but also serve as a thread of hope, a source of joy, and a motivator to engage with learning content. The co-authors share their experiences of how photography has kindled their determination, provided solace amidst life's demands, and instilled a passion for exploration and learning, highlighting its vital role as a catalyst for personal growth and inspiration.

Enya:

“I have photos from a learning experience: one specific photo that I took on my friend’s phone on the morning of our departure will remain precious to me forever, simply because it puts me right back there, in one of our last moments together. I remember not only the wonderful joy of having new friends, but also how education can be something positive, and group work too – a reminder that I need sometimes. Seeing that photo helps me to remember the feeling of hope that I had gained for my career in conservation during that time: I remember knowing without a shadow of a doubt that morning, that if there are people like this, working together in this way, there is a chance that we can actually find a new, kinder, gentler way to live in this world.”

Oliver:

“Photography constantly motivates me to engage with learning content, get out into nature, and observe and apply what I’ve learned in my studies in a very relaxing way.”

Laura:

Being able to see something extraordinary through photography (e.g., because it is very small, very rare, only possible to see far away, or under specific circumstances) supports my motivation to engage with educational content. Seeing the photographs in lectures helped a lot, as well as going out on my own, finding specimens with the aim of photographing anatomical structures or ecological processes, or for example, trying to get my own picture of all the different species helped motivate me to learn where to find, and how to identify different species.”

Valentin:

“This photographic endeavour compelled me to delve into subjects at a much deeper level. My experience with photography led me to undertake an internship at a reptile conservation centre in Brandenburg where photography also plays a significant role.”

The co-authors’ reflections emphasize that photography plays a significant role in self-motivation and self-inspiration. They note that capturing and documenting moments of beauty, resilience, and meaningful experiences serves as a constant source of motivation. Enya highlights the powerful impact of photographs in reinforcing hope for her career in conservation, as images of people working together to protect the environment inspire a belief in positive change. Oliver underscores how photography continuously motivates him to engage with learning content, offering a relaxing and enjoyable way to apply academic knowledge in nature. Laura echoes this sentiment by expressing how extraordinary moments unfold during her field visits, bridging the gap between theoretical knowledge and tangible

experiences, instilling a sense of accomplishment and motivation. These reflections collectively convey the idea that photography isn't just a means of recording moments; it's a tool for nurturing personal growth, passion, and self-motivation, helping individuals stay connected with their aspirations and beliefs.

3.4.2 Entertainment, stress relief and joy

Some of our co-author reflections delve into the delightful and therapeutic dimensions of photography. Beyond its role as a visual medium, photography emerges as a source of entertainment, stress relief, and joy. Co-authors narrate how photography, an art of capturing life's fleeting moments, has simultaneously become a haven for relaxation and an instrument of delight. These reflections shed light on how, through the lens, they have found not only moments of respite from life's demands but also a means to rekindle the joy in simple pleasures. From documenting the extraordinary to cherishing the everyday, these stories illustrate how photography becomes a conduit to unwind and to find happiness in the art of capturing life itself.

Enya:

“The feeling of accomplishment when you get it right the first time is something that I think everyone should have the joy of experiencing. One such moment occurred when I received the developed film photos of a family holiday in Namibia, months after our return. A picture (Figure 24) of my dad and brother being silly in an old broken-down car, in the country that will always be my home long after we have moved on, will remain a cherished memory and a proud accomplishment, and was a wonderful surprise to receive when everyone had returned to the default world and my dear brother was back in Germany. Sometimes, it really is just about capturing that perfect moment and being able to look back on it with all the feelings of peace and joy it contained.”



Figure 24. Enya’s dad and brother in an old, broken car; photo: Enya Munting

Oliver:

“For me, the most important aspect of photography in relation to education is the joy it brings me. Photography has been my main hobby for about three years, enabling me to unwind, escape daily stress, and fully immerse myself in the present moment. It brings me inner peace and pleasantly challenges me cognitively, pushing me to constantly improve, experiment, and discover.”

Laura:

“There is nothing like the joy of capturing the special moment when you see or experience something in real life that you’ve learned all about in a lecture. It is a moment of joy, when you see something abstract, seen on paper, unfold in front of your eyes. Photography helps me capture these moments.”

Valentin:

*“Consequently, my excitement grew as I not only encountered *Vipera berus* but also observed a few *Anguis fragilis* (slowworms), countless *Lacerta agilis* (sand lizards), numerous *Zootoca vivipara* (common lizards), and two *Natrix natrix* (grass snakes). Additionally, the pursuit of locating and photographing birds presented an enjoyable and stimulating challenge for me.”*

Within the realm of personal development through photography, two co-authors reflected on photography’s ability to cultivate mindfulness and enrich the experience of living in the moment. These reflections illuminate how photography, in its process of observation and documentation, becomes a means to transcend the hustle and bustle of daily life, fostering a connection with the present.

Enya:

“Nevertheless, having had an idea of what I could expect helped me to be present and appreciate what I was seeing so much more, and allowed me to better engage with things that fascinate me, such as the politics of Graffiti.”

Oliver:

“Photography has been my main hobby for about three years, enabling me to unwind, escape daily stress, and fully immerse myself in the present moment.”

Again, in the context of personal growth, the same two co-authors delve into how photography acts as a catalyst for deeper introspection and self-development. Their reflections highlight how this visual medium becomes a tool for self-discovery and personal growth, allowing individuals to explore their own identities, values, and artistic expressions.

Enya:

“Learning what is it that I want to photograph and why has allowed me to grow in my own understanding of self. Playing with a film camera has been an immense step in this direction for me, partly because one cannot go crazy and take a million pictures of the same thing, but rather must ensure that the composition and lighting is right for what you want to share with the world, before taking it.”

Oliver:

“Photography not only allows me to develop personally, but also serves as a means of disseminating knowledge.”

One student, Laura, explicitly stressed that photography can have an effect on confidence building and stimulate feelings of accomplishment while Enya speaks about how photography has helped her prepare for the unknown.

Laura:

“Before this, I knew nothing about grasses, after photographing a serious number of different grasses and their identification structures, I felt pretty confident in detecting several species and especially felt confident in examining the identification structures (which is most of the times enough to be able to successfully use an identification book/field guide).”⁸

Enya:

“The education of Homo sapiens reaches so much further than just academics, however, and in this, too, my entanglement with photography has been a blessing. I remember the first time I stepped foot in Europe, coming to terms with how different everything is in a first-world country. I think I would have frozen in uncertainty; had I not been prepared for the fact that things could be this different due to the photos that I had seen.”⁹

⁸ Repetitive text, co-author reflection also used in section: 3.2.4

⁹ Repetitive text, co-author reflection also used in section: 3.1.1

Our student co-authors provided a diversity of perspectives on how photography has benefited them along their educational and personal development journeys. A visual summary of the main themes provided by student co-authors is outlined in Figure 25.

LEARNING	SKILLS DEVELOPMENT	COMMUNICATION	PERSONAL DEVELOPMENT
Enhancing learning materials	Knowledge recall	Enhancing informative content for knowledge dissemination	Self motivation
Making the inaccessible accessible	Creativity	Inspiring / motivating others	Self discovery & introspection
Enhancing understanding & comprehension	Critical thinking	Providing visual language, cues & references	Source of joy, delight & entertainment
Revisiting learning after the fact or experience	Observational skills	Entertaining others	Stress relief / relaxation
Sparking curiosity & challenging photographer cognitively	Emotional recall	Transferring / expressing feelings & emotions	Preparing for the unknown
Bridging the gap between imagination & reality	Species identification	Substantiation / providing visual reference	Providing a sense of accomplishment
Promoting engagement / connection / appreciation for the subject matter		Fostering a connection between audience & subject	Building confidence
Understanding change over time		Conveying ideas	Fostering passion for exploration
Visualizing the invisible		Communicating change over time	Source of inspiration
		Raising awareness	Instilling hope
		Sharing / documenting experiences & memories / story telling	Promoting mindfulness & living in the moment
		Communicating across diverse academic fields & languages	

Figure 25. Summary of student reflections

3.5 Limitation and challenges

We asked our co-authors to reflect on any limitations or challenges related to photography. Surprisingly few comments were made in conjunction with limitations and challenges. In fact, only two students briefly addressed this topic. Laura highlighted that photography can be time-consuming when she said:

“Some of the examples I gave are connected to a big amount of preparation work. I feel working with photographs partly takes a lot of time. Because for me, it’s part of the learning process, it mostly feels like a reasonable amount of time spent.”

Yasmin mentioned that post-editing can be a daunting task when she said that:

“Personally, I believe my photography skills are not that great, I have hundreds of untouched images on my laptop from many trips over the years, the thought of going through them and editing them is daunting to me. This doesn’t mean I don’t enjoy images though, I just prefer the raw unstaged images that contain special memories.”¹⁰

The limited comments on the challenges and limitations of photography as expressed by our co-authors highlight an intriguing aspect of the medium. While there are undoubtedly complexities associated with photography, such as the time-consuming preparation work and post-editing tasks, the co-authors’ relatively few remarks on these challenges could indicate that, for many, the benefits and rewards of photography in education and personal development tend to overshadow its drawbacks.

3.6 Ethical issues

We asked our co-authors to highlight any ethical issues to be considered in relation to photography. Two co-authors pointed out that declarations of consent should be obtained before photographing people and using photographs of people in presentations and publication. Enya also speaks to raising a new generation of ethical photographers.

Michael:

“The only concern would be if someone is identifiable in the photo, however if permission for the photo is given at the time of taking it then it is fine. I think there is a big difference between photos used to generate an income and those used for educational purposes.”

Enya:

“Ethical considerations abound, especially in street photography, where consent is not typically asked for before the photo is taken. In these matters, the ethics of the photographer are of paramount concern, and one can only attempt to raise a new generation of photographers who work from sound ethical foundations.”

One way to respectfully deal with people’s personal rights as subjects in photography is to blur people’s faces in the photograph to be used, and in this way make individual identification impossible. There are also movements (animal advocates) that are attempting to transfer rights that are granted to humans to animal species too. A well-known example is the movement that advocates for great apes to be granted human rights (Waldau & Whitman 2002, Rook 2009, Fraundorfer 2018). If you think about this even further, you could go so far as to be more careful when depicting animals and think about granting certain animal species personal rights, to grant the right to one’s own image. Such an approach would of course be diametrically opposed to many conservation efforts. For example, the opportunity to take photos is an important part of the tourist activities offered in connection with the eastern gorillas (*Gorilla beringei*) in Uganda (Robbins 2018). However, there is a certain awareness of an ethical approach to photographing gorillas beyond this reflection on possible rights to one’s own image. This awareness is expressed in the following statement by Martha Robbins in her essay “Being

¹⁰ Repetitive text, co-author reflection also used in section: 3.6

a good guest - a guide for tourists visiting gorillas” (Robbins 2018, p. 13-14): “Lastly, while it is not an official rule, I suggest that when visiting gorillas you put your camera down for at least five minutes of the hour. Photos are a great way to document your experience, but rather than spending the full hour taking many, many photos, take some time and simply watch the gorillas. Why are you visiting the gorillas in the first place? Is it simply to get a photo or is it for the overall experience?” However, if tourists were to be denied the opportunity to take photos, it might affect their willingness to take action to protect the environment. Another impressive example of the importance of photography for species protection is the Rhino Resource Centre website (<http://www.rhinoresourcecenter.com/>), whose goal, among other things, is to make artistic portrayals and photographs of rhinos accessible and available in order to increase knowledge about these animals (Wilson et al. 2022, Rookmaaker et al. 2023). Moreover, there are numerous photo-based research approaches that play a crucial role for species and environmental protection (Jones et al. 2019, Hofmann & Fleischmann 2020, Kays et al. 2022, Gould et al. 2023). We are by no means advocates of the philosophy and school of thought that non-human animals should not be photographed at all, but we at least point out that certain people could argue in this direction. Here it might even make sense to arm oneself with arguments and provide evidence of the importance of animal photos for species protection. One could imagine that one day, not only people's faces will be blurred, but also those of animals (Figure 26).



Figure 26. A horse and human with both their faces blurred – is this the future of ensuring personal rights to non-human species? Photo: Thomas Göttert

Furthermore, our co-authors recognized that photographers could pose a threat to the environment by harming or disturbing nature in their pursuit for a photograph, and Laura also speaks to ethical behaviour in her caution and reference to the ruthless photographer.

Laura:

“Don’t take photos in places which should not be disturbed (e.g., natural protection zones and private property). Don’t encourage students to be ruthless just for the sake of a nice picture. This is applicable in both an ecological and social context. Using photography as educational material is not an excuse to disturb fragile ecosystems or wildlife.”

Valentin:

“Using photography as an educational tool also implies that people might traverse habitats, potentially disturbing or startling animals. Handling these issues should be of paramount consideration.”

Enya also mentioned that editing and manipulating photos can lead to the development of false narratives. In her reflections Enya said:

“Naturally, photography has its limitations: people take photos of the things that are meaningful, important, and valuable to them, and reality can be exaggerated or compressed in a photo in a way that cannot be done when you are there yourself. It can be used to misconstrue things and can be attached to false narratives. In the age of Artificial Intelligence and Photoshop, these concerns become more imperative every day, as seeing is no longer believing.”

At one point Yasmin said that editing photos was daunting and that it took her away from the fun of the subject. She said:

“Personally, I believe my photography skills are not that great, I have hundreds of untouched images on my laptop from many trips over the years, the thought of going through them and editing them is daunting to me. This doesn’t mean I don’t enjoy images though I just prefer the raw unstaged images that contain special memories.”¹¹

This is a very interesting aspect to consider. We live in times where editing photos takes place without us necessarily noticing it. An example are modern smartphones, where image editing processes are standard, and filters are used without the user even noticing and sometimes perhaps not wanting to. Here, we are approaching a fine line in terms of misrepresenting our subjects in photography. There is a fine line between editing and manipulating. It is also interesting that there is a notion that photos should be edited to use them in a learning context. Some of the authors of this paper aim to edit their photos as little as possible, although others might edit their photos for creative and artistic purposes. A rule of thumb: the higher the quality of the original photo - the lower the quality improvement needed during editing. In other words, a good photo doesn’t get much better with subsequent editing. This is a learning experience that everyone who regularly edits photos has probably had. If I take a photo under suboptimal conditions, I can achieve a significant improvement by editing it afterwards, but a good image won’t get much better. In this respect, a trend towards the most unadulterated

¹¹ Repetitive text, co-author reflection also used in section: 3.5

presentation possible could help to counteract the prevalence of manipulated images and false information. As stated by Ritchie Roesch: “*The future of photography is unedited*” (Roesch 2023). Furthermore, analogue technology might be useful to avoid unwanted and unintended change.

3.7 Student advice for educators using photography in teaching and learning

Our student co-authors also formulated several pieces of advice for educators using photography in teaching and learning. Through their reflections several suggestions were made on how to better integrate photography into teaching and collectively emphasize the multifaceted role of photography as a valuable teaching tool that can enhance the learning environment, promote inter-disciplinary learning, and nurture critical skills while accommodating modern teaching formats. By distinguishing educational from commercial use, involving students in resource development, and fostering collaboration, educators can harness the full potential of photography to create a richer and more engaging educational experience. These hints and suggestions are presented here.

- *“Photography can enhance the learning environment, yet photography and visual stimulation is not fully appreciated in education and more attention should be paid to incorporating visual learning in education.*
- *Photography is well suited as a teaching tool offering a hands-on experience and untapped potential for education.*
- *Photography is inter-disciplinary. Educators should capitalize on the interdisciplinary nature of photography using it to break bubbles and disciplinary silos.*
- *Photography to be used in modern lecturing formats (interactive, self-determined)*
- *Differentiate between photography for education & photography for income.*
- *There is value in developing creativity, critical thinking & observation through photography. Photo-journalism projects in education should be considered.*
- *Use students to help develop materials for education.*
- *Collaborate and cooperate in sharing photographic resources.*
- *Photography is also inter-generational.”*

Michael says he gets the impression that:

“The value of photography, or visual stimulation, is not fully appreciated – especially in educational environments, and even more so in the more ‘scientific’ environments. I feel in most cases it is just a tool, a means to an end.”

4 Discussion

Our exploration into the intersection of photography, education, and personal development has illuminated a rich tapestry of perspectives and revelations. With the intention of gathering diverse insights from a group of student co-authors with a pronounced passion for photography, our discussion sought to examine the subject from a myriad of angles. The students’ reflections, though numbering a select few, have traversed an expansive terrain, touching upon a range of themes and diverging in unexpected directions. This wealth of perspectives and the insights the student co-authors have gen-

erated reaffirm the significance of acknowledging and embracing multifaceted viewpoints when delving into complex subjects. As we embark on this discussion, we celebrate the intrinsic value of diverse lenses through which photography's role in education and personal growth can be scrutinized. We consider the unanticipated insights that have surfaced, explore the dichotomy between knowledge documentation and emotional recall, emphasize the often-overlooked joy of photography in personal development, and underscore the significance of the photographic process, not merely the end result. We also revisit and emphasise ethical considerations and the lasting learning provided by photographs. This multifaceted investigation reiterates the invaluable contributions of diverse perspectives to our collective understanding of the intricate relationship between photography, education, and personal development.

4.1 The significance of diverse perspectives

A fundamental outcome of our exploration into students' perspectives is the breadth of approaches to the subject of photography. Our deliberate aim was to investigate this topic through a multitude of lenses. While the number of student co-authors included in our discussion paper was quite manageable and not particularly diverse concerning ethnic group or discipline, with all coming from the environmental sciences, it was noteworthy that their reflections covered an array of themes and traversed various directions. This underscores the importance of affording students the opportunity to express their thoughts from unique standpoints, facilitating a richer comprehension of the subject. Some students exhibit interest in the technical intricacies of photography, while others contemplate the broader implications of photographs beyond mere knowledge documentation. This interdisciplinary and intergenerational viewpoint reinforces the value of exploring this multifaceted theme. Taking these different perspectives into account is important because technical and content-related aspects can depend on each other, as can be seen in Figure 27.



Figure 27. The information changes depending on which part of the image section is in focus. Above: Different species appear. Below: The focus is once on *Buteo buteo* and once on a celestial body. Photos: Thomas Göttert

4.2 Unanticipated insights and outlier perspectives

As indicated in our methodology, we did introduce a certain degree of expectation by framing the prompts. Consequently, some reflections were unsurprising, while others were genuinely unexpected. It is precisely these unforeseen statements from student co-authors that brings value to our discussion. Consequently, aspects raised by a single student, or a minority can be profoundly relevant. Our initial selection targeted students with an affinity for photography, and the intention was for them to reflect on this shared passion. Despite this, it is intriguing that all students unanimously recognize the paramount role of photography in learning, skills development, and knowledge documentation. Equally fascinating is the emergence of “outliers”, i.e., reflections that transcend the intended categories. These outliers are pivotal outcomes that substantially enrich our discussion. They under-

score that photography plays a role in preparing individuals for unforeseeable circumstances and illuminates the invisible aspects of the world. For a literal example see Figure 28 of contaminants detected in a mushroom growing facility illustrating the diversity of contaminants the eye cannot see.

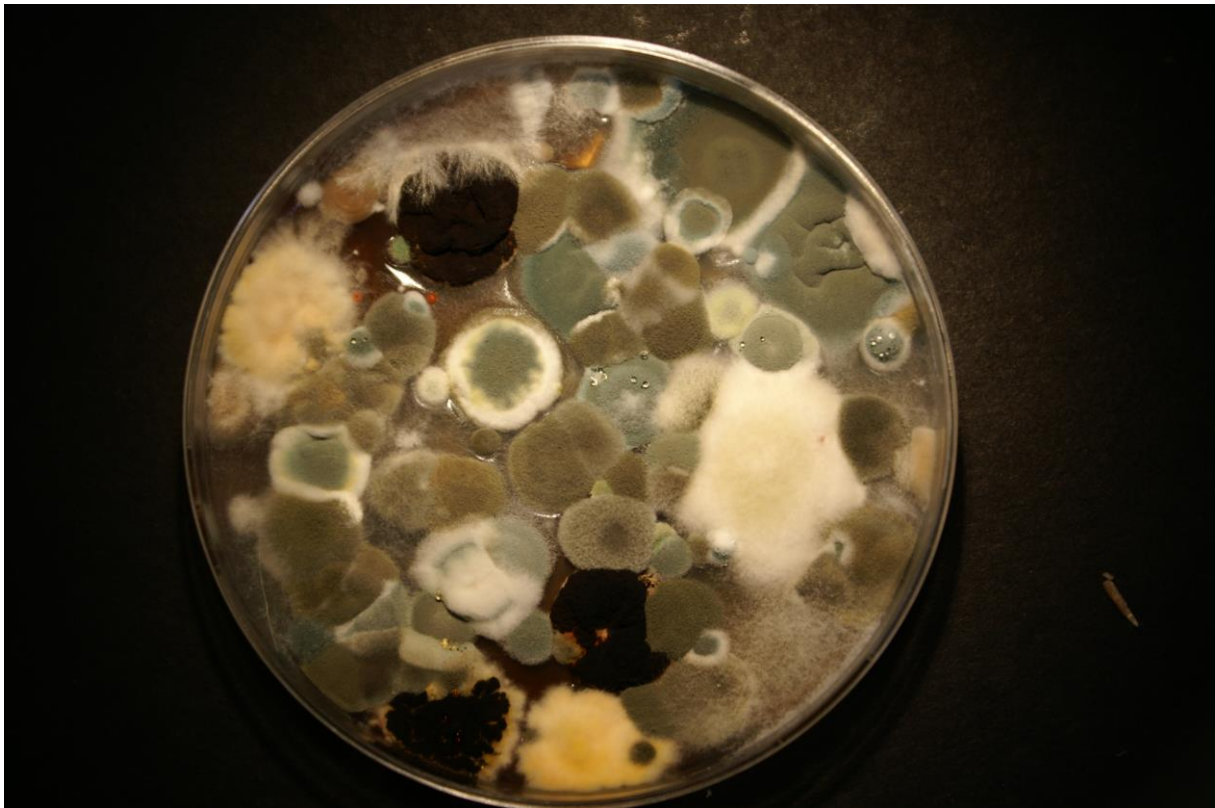


Figure 28. Petri dish showing the diversity of contaminants in a mushroom growing facility, illuminating the unseen; photo: Bianca Currie

4.3 The dichotomy of learning content and emotional recall

One of these pivotal aspects is the dichotomy between knowledge documentation and emotional recollection. It is noteworthy that certain students have acknowledged how photographs, or the mere contemplation of them, significantly contributes to their understanding of concepts and the retention of academic content. Equally remarkable is the revelation that photography serves as a means for individuals to immerse themselves in specific moods or recapture atmospheric “vibes”, thereby enhancing their motivation and engagement in their studies. This transition from esotericism to practical academic use of mood anticipation marks a notable development in the educational landscape. It signifies that aesthetics and image composition can contribute to the recapitulation of memories and moods, thereby adding value to the academic arena. The winter landscape presented in Figure 29, for example, precisely shows those poles that serve as a structure to photograph various bird species preferably during the summer months as outlined in a previous discussion paper (Currie & Göttert 2023, Fig. 8). Re-awareness of the atmosphere associated with this structure on a cold winter day can be very inspiring and motivating if the same structure is the starting point for nature observations during the summer months.



Figure 29. Photograph of a winter landscape, which helped to recall emotions during excursions in that area at a different time of the year. Photo: Thomas Göttert

4.4 Personal development and the overlooked joy of photography

Initially, when conceptualizing the focus of this paper, our intent was primarily centred on educational aspects, and our prompts were tailored accordingly. However, the students' reflections have compelled us to broaden the thematic scope by encompassing the realm of "personal development". This expansion was not premeditated but emerged organically from our exploration of students' perspectives. Notably, the intrinsic motivation and joy derived from photography have emerged as essential facets. Oliver's statement, "*For me, the most important aspect of photography in relation to education is the joy it brings me,*" is particularly enlightening. It is a surprising revelation because one might presume that pragmatic objectives, such as knowledge documentation and academic content retention, would take precedence. This unforeseen focus on the intrinsic rewards and happiness associated with photography challenges the conventional understanding of the role of photography in education.

However, the fun factor should not be underestimated, even from the lecturer's point of view. Own photos of various mammal species taken at numerous zoological gardens are used for organizing educational games to convey learning content in a fun and entertaining way, e.g. biogeographic regions (Figure 30).



Figure 30. Photo quiz used in the classroom; photo of flipchart: Florian Müller; animal photos within photo: Thomas Göttert

4.5 Emphasizing the process over the end result

A significant aspect noted by our students is their valuation of not only the “end product” (the photograph) but also the learning outcomes resulting from the process of photography. Of particular interest is the emphasis on “improving and refining skills”. While it was expected that some students would recognize the value of photography in species identification, the insights extend beyond this realm. Photography serves as a reliable tool for species identification by capturing diagnostic characteristics, but it also cultivates skills that go beyond mere recognition. This entails the ability to assess and discern based on a spectrum of sensory inputs, including animal behaviour within its environment. This distinction in photography’s role, highlighting the development of these multifaceted skills, marks an essential aspect of its educational value.

4.6 The lasting effect of photography

Several student co-authors reflect on the lasting effect of a photograph allowing them to revisit what they learned at a later stage. They also speak of the benefit of being able to revisit images as a reminder of learning. The reflections from various student co-authors highlighting the lasting effect of photographs as tools for revisiting and reinforcing their learning experiences holds significance in the realms of education. Photographs, as visual representations of knowledge and experiences coupled with associated emotions, offer a unique advantage for learners. They act as both anchors and

memory aids, allowing students to revisit the content and contexts of their learning journey. By capturing moments and concepts in a visual format, photography provides a tangible emotional link to past lessons, fostering memory retention.

This aspect of revisiting images as reminders of learning is pivotal for several reasons. Firstly, it extends the learning process beyond the classroom or formal educational settings. Students can constantly engage with their photos, enabling them to maintain a connection to the knowledge they've acquired. The ability to revisit images empowers learners to continually refresh their understanding of the subject matter, keeping it relevant and accessible over time. Furthermore, the practice of revisiting images can be transformative. It allows individuals to reflect on their own growth, evolution, and accomplishments. When students look back at photographs, they often gain a sense of achievement and progress, reinforcing their self-confidence and motivation for further personal development. The ability to revisit images as reminders of learning fosters continuous learning, critical thinking, and personal development. It extends the educational experience and supports learners in their ongoing quest for knowledge, understanding, and growth, making it a valuable tool for education and sustainability transfer.

4.7 Emphasizing ethics

We expected from the outset that the topic of ethical concerns related to photography would be mentioned by our co-authors. It was mentioned rather casually and was by no means a particularly salient aspect articulated by our co-authors. However, we feel it important to emphasise the ethical considerations and developing ethical photographers. Adding to our co-author reflections we recommend that in the context of education and photography, the following ethical issues should be considered:

1. **Privacy and Consent:** Respect for the privacy of individuals is crucial. Obtaining informed consent from people who are photographed, particularly in educational settings, is essential. This ensures that their images are used respectfully and with their permission.
2. **Inclusivity:** Ethical concerns regarding inclusivity and diversity are important. Educators should ensure that the selection of images in educational materials reflects a diverse range of individuals, cultures, and backgrounds, avoiding stereotypes or biases.
3. **Environmental Impact:** The potential harm to the environment should be minimized. Educators and students must be aware of the ecological consequences of photography, such as disturbing wildlife or ecosystems. Photographers should follow ethical guidelines to minimize their impact on nature.
4. **Truthfulness and Integrity:** The manipulation of photographs to convey false information or narratives should be avoided. Both educators and students should uphold the principles of truthfulness and integrity in photography and clearly distinguish between unaltered photos and those that have been edited or enhanced.
5. **Cultural Sensitivity:** When using photographs in an educational context, cultural sensitivity is crucial. Images and visual materials should be chosen and presented in a manner that respects and acknowledges cultural norms, practices, and sensitivities.
6. **Copyright and Intellectual Property:** Respecting copyright and intellectual property rights is essential. Educators and students should be aware of copyright laws and use images in accordance with these regulations, giving proper attribution and permissions when required.

7. **Educational Integrity:** Students should refrain from engaging in unethical practices, such as plagiarism, when using photographs in academic assignments or projects. Proper citations and attributions should be maintained.
8. **Data Privacy and Security:** When images contain personal data or sensitive information, data privacy and security must be upheld. Educators should be cautious when sharing or storing images to protect the privacy of individuals.

These ethical considerations are vital in promoting responsible and respectful photography in educational contexts, ensuring that images are used as valuable tools for learning and communication while respecting and upholding ethical standards. It provides a base from which to develop ethical photographers and discourage those ruthless photographers that our co-author mentioned.

4.8 Recognizing our bias and mentioning the digital divide

In addition to the reflections from our co-authors in relation to the challenges and limitation of photography, one notable issue not mentioned is the digital divide at macro spatial levels (e.g., the Global North and South, national and regional levels) and intra-urban scales (e.g. a singular city) (Otioma et al. 2019) where socio economic factors influence access to information and communication technologies and which applies to photography equipment, resources, and digital literacy skills. It can create disparities in educational opportunities, as students with limited access to cameras, smartphones, or editing tools may face obstacles in engaging with visual learning and photography-based assignments.

Disparities in access to information and communication technology are found across socioeconomic factors (Otioma et al. 2019). Individuals from more economically developed regions and higher income brackets tend to have better access to technology. Conversely, those from less economically advantaged backgrounds face barriers to entry into the digital sphere, further perpetuating inequality. Additionally, the digital divide extends its reach into the realm of education. This knowledge divide can manifest in various ways, from the ability to navigate the digital landscape to leveraging technology for educational and professional advancement. Furthermore, even within the subset of individuals with access to a broadband connection, a nuanced form of digital division emerges. Factors such as low-performance computers, limited broadband speeds, and restricted access to subscription-based content can exacerbate existing inequalities. These challenges hinder the full utilization of digital resources and can create disparities in opportunities and outcomes among users. Addressing these disparities requires concerted efforts to bridge gaps in access, infrastructure, and digital literacy, ensuring that technology serves as an equalizing force rather than a source of further division.

It is interesting that the students did not raise the digital divide as an issue or challenge. To one of the authors (Thomas), inadequate equipment was a major issue during his PhD studies: While spending a 16-month period on a farm complex in Namibia to study the behaviour of reintroduced rhinos, I was also using photography to document vertebrate species for an inventory of the study area. I only had access to a rather simple digital camera and the limited picture quality was something that bothered me all the time. I knew that this is a once in a lifetime opportunity for photo documentation, but I could not afford decent equipment at that stage in my career. This felt somehow unfair at the time.

At one point, Laura reflected on how things have changed in terms of equity and access to resources when she spoke of the old photograph she recreated with colleagues. She reflected on how the old photo reflected a group of young male students and teachers contrasting this with the recreated photo showing people of different genders from different places, older, younger, students and teachers.

We should, however, not forget that there are still many issues of concern – the world is not that “happy woke all-gender mixed-up space”. For example, it is important to note that the South African authors in this paper are all white persons, which manifests inherent bias in this paper. Likewise, it is known that in Germany, East Germans remain underrepresented in high-level jobs (Junkermann 2023) and thus, a disproportionately high number of the professors at Eberswalde University – although being located at the easternmost corner of Germany - grew up in former West Germany. The lack of reference to the digital divide is perhaps less about the rewards of photography outweighing the challenges and more about the biases inherent in the collective authorship of this discussion paper.

5 Concluding remarks

In conclusion, our exploration into the student perspective reveals a rich tapestry of insights that significantly contributes to the understanding of photography’s multifaceted role in education and personal development. The unexpected observations and unconventional perspectives serve as essential elements in comprehending the broader implications of photography in the academic domain.

Our discussion paper has delved into the multifaceted role of photography in education and personal development. The students’ reflections, each offering a unique viewpoint, have shed light on the diverse ways in which photography enriches the academic experience and nurtures individual growth. As we summarize the key takeaways from their perspectives, several overarching themes emerge.

Foremost, the breadth and diversity of perspectives unveiled in our exploration underscore the paramount importance of providing students with a platform to voice their reflections. This inclusive approach allows us to achieve a more holistic understanding of the subject, encompassing a wide spectrum of viewpoints, ranging from technical intricacies to aesthetic considerations and the broader implications of photographs in knowledge dissemination. However, it is essential to acknowledge the inherent biases within our relatively small co-authorship group. We must recognize that the realm of student perspectives on photography in education, learning, skills development, and personal growth is vast and intricate. Our exploration represents merely a glimpse into this multifaceted domain, shaped by the insights of a limited number of participants in the discussion and all of which come from a similar disciplinary domain.

Unanticipated insights, the “outliers” within our student reflections, have proven to be of most interest and importance. These unexpected perspectives, often diverging from conventional wisdom, contribute a substantial portion of the paper’s value. They underscore that photography extends beyond predictable boundaries, serving as a preparatory tool for unforeseeable circumstances and providing access to the invisible elements of the world.

The dualism of knowledge documentation and emotional recall emerges as a significant theme. Students report that photography enhances their grasp of academic concepts and contributes to better knowledge retention. Equally intriguing is the use of photography to rekindle specific moods and atmospheres, infusing motivation, and engagement into academic pursuits. This acknowledgment of the role of aesthetics and mood anticipation broadens the horizon of photography in education.

Personal development and the joy of photography, an aspect that transcends traditional academic objectives, have surfaced as a central theme. The intrinsic motivation and happiness derived from photography challenge the conventional understanding of its role in education. The unanticipated focus on the intrinsic rewards of photography showcases the deeper connections that students have formed with this art form.

Lastly, our exploration revealed that the process of photography often holds as much, if not more, educational value than the end product. The development of skills, such as species identification and the ability to assess complex situations, through the act of photography signifies an essential aspect of its role in education and its appeal to the visual learner.

Collectively, the students' reflections demonstrate that photography is not confined to a mere documentation tool but is, in fact, a versatile instrument that enriches learning experiences, stimulates personal development, and enhances the academic journey. The valuable insights shared by our student co-authors prompt us to further appreciate the far-reaching implications of this medium in education, personal growth, and beyond. This paper underscores that capturing knowledge and moments through a camera lens transcends the mere visual realm, impacting the intellectual and emotional dimensions of our lives. Photography, as illuminated by our student co-authors, is a multifaceted tool, a bridge between the known and the unknown, and a companion on the journey of learning and personal development.

Our paper makes a significant contribution to the topic of sustainability transfer, which can be defined as the exchange of knowledge, ideas, experiences, and technologies between the spheres of science and society (Nölting et al. 2021). This contribution arises from highlighting how photography can play a pivotal role in the broader context of knowledge dissemination, skills development, and personal growth. It also highlights how photography can help to transcend disciplinary boundaries helping students integrate disciplines in their learning. The diverse range of insights from our co-authors underscores that the educational and personal development benefits of photography extend far beyond traditional classroom boundaries. It provides a fresh perspective on sustainability transfer, revealing that the impact of this transfer is not limited to ecological or conservation knowledge but also encompasses social knowledge, an emotional, aesthetic, and motivational dimension. By recognizing the often-underestimated influence of aesthetics, mood, and personal engagement within the educational process, this paper broadens the horizon of sustainability transfer. It reinforces the idea that promoting sustainable practices is not solely an academic endeavour but also a personal and emotional one, thereby encouraging a holistic and comprehensive approach to sustainability. In doing so, this discussion paper encourages us to reconsider the avenues through which knowledge is transferred, emphasizing visual learning and the need to address both intellectual and emotional aspects in the journey towards a sustainable future.

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8 Appendix

Dear all,

You have been invited to co-author a paper on the use of photography in education led by Drs Thomas Göttert and Bianca Currie, where we hope to explore student perspectives on photography's impact in learning. The paper is thought as a follow up to a discussion paper recently published here: <https://doi.org/10.57741/opus4-636>.

The following text presents the draft executive summary laying out the thinking for the paper and providing a bit of context for the piece.

Executive summary:

For this exploration, students themselves stand as co-authors, lending their unique perspectives and experiences to enrich our discourse. As education evolves in the digital age, the integration of visual elements becomes increasingly essential. In response, we undertook to understand the role of photography from the vantage point of students. We gathered insights that highlight the profound impact of photography on learning, knowledge retention, and engagement.

Our findings unveil the multifaceted benefits that students derive from photography. The visual medium not only reinforces conceptual understanding but also encourages active participation and fosters creative expression. In an era where information overload is a challenge, photography emerges as a potent tool for distilling complex ideas and facilitating learning. The co-authorship of this paper signifies our commitment to amplifying student voices, providing them with a space to share their journeys of discovery and empowerment through photography.

Through anecdotes and reflective narratives, it is our hope that this collaborative endeavor will inspire educators, researchers, and institutions to acknowledge and harness the transformative potential of photography in education. As students and co-authors, we advocate for the inclusion of visual elements, fostering a more holistic and engaging learning environment that empowers learners to see the world through a new lens.

We are eager to learn of your experiences and hear your opinions on how photography may have influenced your learning experiences in the past and in the present. We would also appreciate examples (personal stories), and no more than three photographs to publish in the paper which can illustrate the points you might make. This will best come across if you write in the first person.

Please note your text contribution may be edited for grammar and spelling but not in terms of content, if the lead authors wish to make any significant edits to your text, this will be discussed with you. However please note that we may not use your entire text or all your photos in the final draft. We don't want your participation in this paper to become burdensome or overwhelming and therefore the commitment we ask of you includes:

1. Submitting no less than one page of text (more is welcome) as written contributions to the paper, discussing how you have experienced or used photography to learn.
2. Submitting no more than three photographs accompanying your text illustrating examples.
3. The opportunity to review and provide inputs on a draft prior to publication. We do not expect your ongoing input and comment on interim drafts of the paper.
4. If necessary, we may need your participation in a virtual meeting to finalise any detail prior to publication.

Find a few questions to prompt your writing but please speak from your own experiences and using your own stories, and if the questions do not resonate with you, don't feel obligated to answer them. The questions are merely there to prompt your thinking and get you going with the writing.

Prompting questions – your experiences:

1. How have photographs or images helped you to learn new things?
2. Can you recall a specific instance where photography played a significant role in your understanding of a scientific concept or subject matter?
3. Describe any projects or assignments where you actively used photography as a learning tool. What were the outcomes?
4. Have you noticed any differences in your engagement with educational content when it includes visual elements, such as photographs? If so, how does it impact your comprehension?
5. How does photography influence your knowledge retention? Do photos help you to remember things? Does it help with recall? How?
6. How does photography influence your engagement with the subject matter?
7. Can you provide examples of how you've collaborated with peers or educators using photography to explore educational or scientific subjects?
8. Have you ever encountered a situation where you felt that photography allowed you to express your ideas or insights more effectively than traditional written assignments? Please elaborate.
9. Have you experienced any challenges or limitations when using photography as an educational tool?
10. Reflect on your personal photography skills. How has this impacted your use of photography in learning.

Prompting questions - Your opinions

1. What contributions can photography make to learning experiences?
2. How do you think photography can help bridge gaps in understanding for complex scientific topics or phenomena?
3. In your opinion, what role should photography play in the future of education, and how might it evolve?
4. Are there any ethical considerations or concerns that you think should be addressed when using photography as an educational tool? How can these challenges be mitigated?
5. What advice would you give to educators and institutions looking to incorporate photography into their teaching methods based on your experiences?

6. How do you think photography can help foster creativity and critical thinking in the learning process, particularly in subjects like science?

Please submit your contribution to curriekillick@gmail.com by 21 September 2023 for inclusion. When submitting your contribution please include your full name and your affiliated organisation(s), and study programme (e.g., Mr. Joe Smith, PhD economics student at University of Cape Town) so that we can accurately list you as a co-author.

Should you have any question or need to reach out, feel free to contact Dr Thomas Götttert (thomas.goettert@hnee.de) or Dr Bianca Currie (curriekillick@gmail.com).

Kind regards from the both of us,

Thomas and Bianca

About the authors

Thomas Göttert

After studying biology at Martin Luther University Halle-Wittenberg, Thomas studied the post-release spatial ecology of reintroduced African rhinos in Namibia and received a doctoral degree (Dr. rer. nat.) from the University of Veterinary Medicine Hannover, Foundation. Thomas worked at the Natural History Museum in Berlin and Humboldt-Universität zu Berlin and is currently affiliated with Eberswalde University for Sustainable Development. He has almost 20 years of international teaching experience and a strong research interest in central European and southern African ecosystems.



Photo: Ria Göttert

Bianca Currie

Bianca completed undergraduate studies in conservation and went on to receive a PhD focusing on social learning in water management in a complex social ecological system in South Africa from the Nelson Mandela University. Bianca has 12 years of teaching conservation communication, environmental education and research methodology at the School of Natural Resource Management while holding the position of director of the Sustainability Research Unit at the Nelson Mandela University until 2020. Since then, she has taken up a position as chief executive of the UNESCO Garden Route Biosphere Reserve where she puts theory into practice and continues to supervise post graduate research related to biosphere reserves as a research associate at the Sustainability Research Unit.



Photo: Bianca Currie

Valentin Backa

Valentin Backa, born on November 16, 1993, in Berlin, has been working as a glazier journeyman since 2018 and began studying Landscape Management and Nature Conservation at Eberswalde University for Sustainable Development in 2022. Additionally, for the past 20 years, he has pursued an interest in keeping reptiles and herpetology.



Photo: Valentin Backa

Laura Feldenz

Laura studied International Forest Ecosystem Management (IFEM) at the Eberswalde University for Sustainable Development. Simultaneously she worked at the university in digital learning enhancement and media production. Laura now studies Biodiversity, Ecology and Evolution at Freie Universität Berlin and works in scientific communication for a nature conservation project that is part of the EU-co-funded interregional cooperation programme (Interreg).



Photo: Jan Feldenz

Michael Klaver

Michael is currently a MSc Nature Conservation student with the Sustainability Research Unit and School of Natural Resource Science and Management at Nelson Mandela University. His research is exploring biosphere reserve governance models and collaborative Cape leopard conservation efforts in the Boland Mountain Complex of South Africa. His academic background is in both geography and nature conservation, which he believes aids him in viewing conservation challenges through a social-ecological systems lens. He is interested in human-nature connections and the human-wildlife interface. He is a hobbyist photographer and enjoys trail running, cycling, hiking – anything outdoors.



Photo: Bianca Currie

Yasmin Markides

Yasmin is a nature conservation student pursuing her BSc Honours Natural Resource Management at Nelson Mandela University George Campus. In the future, she hopes to obtain her Master's degree in conservation and find work thereafter. Her ultimate goal is to one day work as an ecologist or conservation manager in a remote conservation area. In her free time she enjoys reading, sometimes a bit too much, and spending time with her partner and dogs.



Photo: Michael Klaver

Enya Munting

Enya grew up in Namibia, a southern African country full of pristine nature, and took up photography as a hobby in grade 10 when she received her first camera for her birthday. She is in the process of finishing her MSc in Environmental Science at Rhodes University, with the South African Institute for Aquatic Biodiversity. Her passion and life's work is in understanding and working towards healing people's relationship with Nature and Protected Areas. This goal is well served by her love for nature, people, and photography, as well as her commitment to interdisciplinary methods for learning and communication.



Photo: Karen Munting

Oliver Rolfes

Oliver studies Landscape Management and Nature Conservation in his third semester at Eberswalde University for Sustainable Development. He has been enthusiastic about wildlife photography for about a year now and often uses it as a tool in his scholarly pursuits.

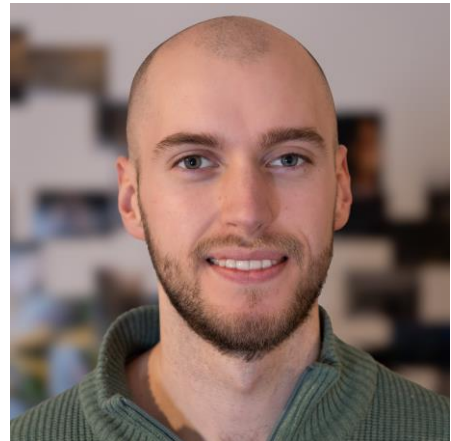


Photo: Oliver Rolfes

Bisher veröffentlichte Diskussionspapiere des Forschungszentrums [NTT]

- Nr. 1 / 22 Göttert T, König B, Nölting B, Roose I, unter Mitarbeit von Crewett W, Demele U, Fritz H (2022) Konzeptpapier – Perspektiven auf Nachhaltigkeitstransformation und -transfer an der HNEE. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 1/22). <https://doi.org/10.57741/opus4-224>
- Nr. 2 / 22 Roose I, Nölting B, König B, Demele U, Crewett W, Georgiev G, Göttert T unter Mitarbeit von Hobelsberger C (2022) Nachhaltigkeitstransfer – ein Konzept für Wissenschafts-Praxis-Kooperationen. Eine empirische Potentialanalyse am Beispiel der Hochschule für nachhaltige Entwicklung Eberswalde. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 2/22). <https://doi.org/10.57741/opus4-272>
- Nr. 3 / 22 König B, Nölting B, Crewett W, Demele U (2022) Methode und Meta-Daten zur bürgerwissenschaftlichen Studie „Logbuch der Veränderungen“. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 3/22). <https://doi.org/10.57741/opus4-277>
- Nr. 4 / 22 Gutsohn A, Selleneit T, König B, Nölting B (2022) Solidarität und solidarisches Verhalten in der Corona-Pandemie. Ergebnisse aus dem „Logbuch der Veränderungen“. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 4/22). <https://doi.org/10.57741/opus4-360>
- Nr. 5 / 22 Gutsohn A, Wiemers H, König B, Nölting B (2022) Information, Kommunikation und die Entwicklung digitaler Kompetenzen in der Corona-Pandemie. Ergebnisse aus dem „Logbuch der Veränderungen“. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 5/22). <https://doi.org/10.57741/opus4-368>
- Nr. 6 / 22 Selleneit T, Verdugo-Raab D, Kipp S, Sprenger D, König B (2022) Sozioökonomische und ökologische Bewertung des Einsatzes von Kunststofffolien im Spargelanbau in Deutschland und daraus resultierende Handlungsempfehlungen. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 6/22). <https://doi.org/10.57741/opus4-376>

- Nr. 7 / 23 Stahl JK, König B, Gutsohn A (2023) Die Natur in der Krise? Auswirkungen der COVID-19 Pandemie auf das Verhältnis zwischen Mensch und Natur in Deutschland. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 7/23). <https://doi.org/10.57741/opus4-406>
- Nr. 8 / 23 Currie B, Göttert T (2023) The value of photography in science and education - Photography through the lens of two scholars. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 8/23). <https://doi.org/10.57741/opus4-636>
- Nr. 9 / 23 Göttert T, Hobelsberger C, König B, Nölting B, Roose I (2023) Kartierung von Nachhaltigkeitstransfer? Entwicklung einer Methode zur Sichtbarmachung von Nachhaltigkeitstransferaktivitäten. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 9/23). <https://doi.org/10.57741/opus4-666>
- Nr. 10 / 23 Gutsohn A, Hahnle M, König B, Nölting B (2023) Veränderte Arbeitspraktiken und –bedingungen in der Corona-Pandemie – Ergebnisse aus dem „Logbuch der Veränderungen“. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 10/23). <https://doi.org/10.57741/opus4-788>
- Nr. 11 / 23 Göttert T, Currie B, Backa V, Feldenz L, Klaver M, Munting E, Markides Y, Rolfes O (2023) Framing growth: exploring the transformative power of photography for students. Eberswalde: Hochschule für nachhaltige Entwicklung Eberswalde (Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer, Nr. 11/23). <https://doi.org/10.57741/opus4-792>

Diskussionspapier-Reihe Nachhaltigkeitstransformation & Nachhaltigkeitstransfer

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