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Animal Welfare and the United Nations' Sustainable Development Goals—Broadening Students' Perspectives

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Abstract: The mutually beneficial relationships between improving animal welfare (AW) and achieving the United Nations (UN) sustainable development goals (SDGs) were further explored and compared to previous work. This was done in the context of a doctoral training course where students selected at least six SDGs and reasoned around their impact on AW and vice versa. Then, students rated the strength of the SDG—AW links. Lastly, students engaged in an assessment exercise. Students reported an overall mutually beneficial relationship between AW and all SDGs, yet with significant differences in strength for SDGs 4, 11, 10, 12 and 13 to that previously found by experts. Students considered SDG 12: Responsible consumption and production the most promising way to integrate AW targets. This study further supports the positive role of AW in the success of the UN's strategy. Still, the magnitude of the anticipated impacts is modified by stakeholder, context and experience.

Keywords: sustainability; animal welfare; education for sustainable development (ESD); learning environment; critical thinking

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1. Introduction

In 2015, the 17 sustainable development goals (SDGs) were adopted by the United Nations (UN) [1]. The overall aim was a global project "to shape our common future in a new, better and more intentional way" [2]. Although animal welfare is not explicitly mentioned in the SDGs, it is an intrinsic part of them. Concern about animal welfare is not new, with the legislation in this area being well over 100 years old, and the topic of animal welfare, its impact on society and the scientific study of it, is of increasing importance [3,4]. The term "one welfare", inspired by the concept "one health", is used to emphasise the many links between animal welfare and human welfare, and to acknowledge that both depend on a well-functioning ecological environment [5]. Looking to the future, Buller et al. [6] highlighted the relevance of animal welfare for the interlinked challenges of food security, socio-economic development, human wellbeing and environmental conservation.

Initially, work linking animal welfare and sustainability-focused on livestock and the production of food for human consumption [7]. Improving animal welfare was included as a goal in the UN Committee on World Food Security recommendations on sustainable

agricultural development for food security and nutrition, including the role of livestock [8]. There are activities within the Global Agenda for Sustainable Livestock, e.g., the Animal Welfare Action Network, whose aim is integrating animal welfare into sustainable livestock production to deliver the SDGs [9]. Livestock and food production are very important, but sustainable development, as expressed in the concept of the indivisibility inherent in Agenda 2030, is so much broader than only these areas.

The Agenda 2030 recognises that the welfare of people depends on the health of the global ecosystem within which we live, and the welfare of *all* animals (domesticated and wild) is critical if this ecosystem is to be sustainable in the future [10,11]. Recent reports on the general status and trends within biodiversity have also revealed a rapid decline of wildlife populations caused by overharvesting of populations and fragmentation of key habitats leading to stress, starvation and disease [12,13]. The Food and Agricultural Organisation (FAO) has shown that by 2016, 559 of the 6190 domesticated breeds of mammals were recorded as extinct [14], and an additional 1940 local breeds are on the brink of extinction, leading to a reduced genetic variability [12]. Finally, and perhaps the most discussed of the grand challenges for sustainable development, is climate change. Animals are both contributors of total Green House Gas emissions (e.g., the livestock sector, including its supply chains, has been estimated to account for 14.5% of the total emissions) [15] and saviours in this area (e.g., marine animals contribute to the carbon sequestration in the oceans) [16]. The pressure to reduce emissions is high, although work on mitigation strategies, at least within animal agriculture, has been criticised for not adequately considering animal welfare [5,17–19].

That animal welfare is an intrinsic part of all the SDGs, was one of the conclusions of the study by Keeling et al. [20]. In that workshop, participants (with expertise in areas of animal science, veterinary science, biology, agriculture and ecology), were asked to rate the impact of achieving each of the SDGs on animal welfare, as well as to rate the impact of improving animal welfare on that SDG, inspired by Nilsson et al. [21] and Weitz et al. [22]. For each SDG, the average impact was always positive, with some, e.g., SDG 12: Responsible consumption and production and SDG 14: Life below water showing quite strong mutual synergies between achieving the different goals and improving animal welfare. Closer examination of the full range of ratings, however, revealed that some participants saw a conflict rather than a synergy for particular SDGs. For example, in connection with SDG 2: Zero hunger it was noted that improved nutritional status of animals may come at the cost of increased hunger in human populations because of food-feed competition. Given that participants were asked to think freely, it is not unreasonable considering their different scientific and cultural backgrounds, that they had different contexts in mind during the exercise and integrated these contexts to a greater or lesser extent in their final scores. Even if the overall conclusion was that working towards achieving each of the SDGs is likely to improve animal welfare and that improving animal welfare can contribute to achieving the SDGs, there is a need to explore variation between individuals and consider various scenarios, if these synergies are to be realised in practice. Improved understanding of the dynamics of interactions is a necessary step towards building coherence in policy-making for the 2030 Agenda [23]. In the literature, it has even been suggested to have an SDG 18: Animal health, welfare and rights, due to the importance that animals, domestic and wild, have for us to reach sustainable development [18].

Environment and education ministers from the United Nations Economic Commission for Europe region adopted the Strategy for Education for Sustainable Development [24]. The strategy aims to ensure that policy frameworks enable education for sustainable development at all levels of formal and informal learning, provide support for educators in the field of sustainable development, and facilitate access to adequate teaching aids and educational materials needed [25]. One of the most important recommendations in the strategy is to mainstream sustainability into the curriculum at all levels of education. Work exploring how best to do this highlights the importance of "critical thinking" and "systems thinking" [26]. Animal welfare is complex, it is multi-faceted, and education on

this topic must take on board sustainable development, not only from the animal's point of view but from the student's point of view.

The work reported here is a follow-up to the study reported by Keeling et al.[20], but this time we also investigated the role of pedagogical aspects of a tertiary-level education course on the perceptions of the links between AW and sustainable development. The course on AW and the SDGs provided a set of international graduate students as stakeholders. During the course, they repeated the exercise from Keeling et al. [20] and rated the strength of the links between animal welfare and each of the SDGs, and on several occasions, they were asked to select the SDGs they thought to be most relevant to AW based on the type and level of detail of different AW issues. The aim was to further explore the links between AW and SDGs, and the hypothesis was that the context (i.e., the animal welfare issue being considered) would alter which SDGs are identified as being associated with AW.

2. Materials and Methods

This paper is based on five assignments carried out in association with a four-day meeting during a postgraduate summer school (3 credits = two weeks of full-time work according to European Credit Transfer) at the Swedish University of Agricultural Sciences (SLU) in June 2019.

2.1. Participants Description

There were 15 students from eight different countries (Austria, Brazil, China, Mexico, Norway, Sweden, Switzerland and the UK). Students were guided by three-course leaders who acted as lecturers or discussion facilitators and six guest lecturers who also contributed case study material and to the discussions.

The participants responded to an international open invitation to a course organised by the Graduate School for Veterinary Medicine and Animal Sciences at SLU in combination with the Global Challenges University Alliance. The backgrounds of the students who participated in the summer school included bachelor or master level education in animal science (n = 2), veterinary medicine (n = 7), biology (n = 3), agronomy (n = 1), ethology (n = 1), sociology and psychology (n = 1). Their research projects involved cattle (beef & dairy; n = 2), pigs (n = 3), horses (n = 3), poultry (n = 2), fish (n = 1), goats and sheep (n = 1), companion animals (dogs and cats; n = 2) and wildlife (n= 1). They dealt with topics such as production system improvements (n = 8), animal welfare assessment and health (n = 3), farmers' attitudes (n = 1), animal welfare legislation (n = 2) and behavioural ecology (n = 1).

2.2. Summer School Course Description

The summer school was designed for students to learn and develop the necessary tools to think critically about the relevance of their research on AW to the SDGs. We used the definition of animal welfare proposed by the World Animal Health Organisation "Animal welfare means the physical and mental state of an animal in relation to the conditions in which it lives and dies" [27]. Students were asked to consider how their research could contribute to the attainment of SDGs and the conflicts that might arise from the pursuit of other SDGs. The learning environment had a multidisciplinary knowledge transfer between participants at its core. The learning process was interspersed with lectures on animal welfare, ethics, complexity analysis, sustainable development and social responsibility in the food chain, as well as specific livestock production, companion animals and working equines topics. In this way, the course aimed to determine whether the associations found between SDGs and AW differed from those found in the previous workshop on the same topic where the participants were more experienced in AW (see [20]). It is the information gathered during this course that was the basis for this paper.

The participating students were briefed about the course and research aims and gave informed consent for the data gathered during the course (i.e., rating results, discussion notes and assignments) to be used by the authors for such purposes.

In summary, the course consisted of:

1. Three core assignments (A1–A3) issued at different time points in the learning process. There was a *pre-course* individual assignment (A1); an *in-course* group assignment (A2) and, lastly, a *post-course* individual assignment (A3). At each assignment, a key objective was for participants (individually or as a group) to select at least six SDGs where they identified a supportive or conflicting relationship with AW and to explain it. Students were divided into three groups dealing with: livestock (cattle), working animals (equines) and companion animals (dogs), for A2.
2. A *rating activity* (A4) on the strength of the associations between each SDG and AW
3. An *assessment activity* (A5) to select the SDG within which the AW agenda can best be included, and which renders the highest supportive effect between the UN agenda and improved AW.

The rationale for this approach was to track the individual student's evolution of their perceptions of how AW and SDGs are interrelated. Thus, the point of departure of the analysis was each student's personal pre-course knowledge and experience (A1 *pre-course*). Prior to the course, each student listed at least six SDGs that they thought were most closely related to AW in either a positive or negative way. From that point onwards, the participants were taken along an analytical pathway of increasing complexity. Participants were exposed to empirical knowledge in a set of lectures, discussions and reflections (see Supplementary Material) to enable them to analyse complex relationships between the biophysical, economic and social elements that could be present when considering AW—SDG relationships. This work was followed by discussions, in three groups of 5 students each, of case-specific scenarios (A2 *in-course*) purposely unrelated to the area of work of the participants. The discussion was complemented by lectures made by experts in the case study areas. The students then expanded on the problems identified in the case and shared their perspectives and rationale of how AW and SDG were linked in that specific context.

At this point, the student participants were instructed, as was done in 2019 with the expert participants, to rate the strength of association between SDGs and AW, and vice versa (*rating*, A4). In short, participants evaluated the association on a 7-point scale from indivisible (score +3: where the achievement of the SDG is inextricably linked to improved animal welfare), via reinforcing (+2), enabling (+1), consistent (0), constraining (−1) counteracting (−2) to cancelling (score −3, where it is impossible to reach both the SDG and improved animal welfare at the same time). The wording was standardised (How do you rate the impact of achieving this SDG on animal welfare? How do you rate the impact of improving animal welfare on this SDG?). Students responded individually using interactive polling and were blind to the rating of the others. For more details of the methodology, see Nilsson et al. [21] and Keeling et al. [20].

An assessment group work exercise (A5) was then performed. Here, participants were split into four new working groups and instructed to select a single SDG where an AW agenda would have the greatest supportive impact. The group was even asked to formulate how AW could be included as a specific action point under this selected SDG. They were then asked to convey their rationale to the participants from the other groups in a 3-min presentation. After listening to all presentations, each participant made an independent individual rate for which of the SDGs selected by the groups, they believed had the strongest synergy with AW.

Lastly, all students completed a take-home assignment. Here students were asked to do a final selection of at least six SDGs linked to AW, but this time departing from their own area of research (A3 *post-course*).

2.3. Descriptive Analysis

Course leaders kept a record of the SDGs chosen by the participants as well as notes about their rationale and key arguments when presenting these selections. With the generated data, we did a descriptive comparative summary of the SDGs participants selected in assignments A1 *pre-course*, A2 *in-course* and A3 *post-course*. We aimed to highlight potential selection differences based on the type and level of detail of the AW issue analysed (e.g., within the context of a defined problem vs. a general vision or agenda). We hypothesised that increased detail around an AW issue (i.e., a specific context) would alter which SDGs are identified as being associated with AW. Moreover, we wished to identify any potential evolution or progression of thought during the course in what students identify as a key SDG. By that we mean, those SDGs where there is a positive relationship with improved AW and where an improvement in AW can help achieve the general agenda around that SDG. A selection of quotes from students' work is presented to illustrate key ideas and experiences.

The *rating* (A4) by the students participating in this summer school was summarised using the same descriptive methods (radar chart and scatter plot of the means of the rating results) as for the previous workshop [20]. Then both sets of results were compared statistically using Mann–Whitney U tests to explore the extent to which original findings apply with a different stakeholder population. A non-parametric analysis that makes no assumptions about the data was used, given that the two datasets were collected at different times and in different situations.

3. Results

The results are presented firstly, according to the evolution of the participants' knowledge (A1 to A3, *pre-*, *in-* and *post-course*). Secondly, regarding how the links between AW and the SDGs (A4, *rating*) identified by the graduate students compared to that of the group of experts in the previous workshop. In the third section, we report the results of the *assessment exercise* (A5). A curation of quotes has been added in support of observations made by the participating students.

3.1. Evolution of SDGs Selection in Relation to AW Context in A1 to A3, Pre-, in- and Post-Course

Results from the first assignment (A1 *pre-course*) represented the baseline knowledge of participants regarding the interactions between AW and the SDGs. The selection made by the students showed a large variation in how easily relationships between AW and the different SDGs were initially seen by participants (See A1 *pre-course* results in Figure 1). More than 70% of the students found a relationship between AW and SDGs 2: Zero-hunger, 12: Responsible consumption and production, 13: Climate action, and 15: Life on land. No participants identified a relationship with SDGs 5: Gender equality and 17: Partnerships for the goals, whilst very few (<10%) students could identify a relationship between AW and SDGs 7: Affordable and clean energy, 9: Industry, innovation and infrastructure, 10: Reduced inequalities, and 11: Sustainable cities and communities.

Below are some quotes extracted with permission from the essays that the participants were required to submit during the A1 *pre-course* explaining why they had chosen these specific SDGs. In this way, participants could recognise that there were different perspectives even if they felt they might lack the expertise to have a definite opinion.

> *"Animal welfare as a concept can be interpreted in multiple ways, which can have a considerable effect on what is considered important or what criteria are included in the first place. For this discussion, animal welfare concerns itself with the subjective experiences of animals, encompassing cognitive and behavioural needs rather than simply looking at health and productivity. I will also only examine farm animal welfare, rather the welfare of animals used for entertainment and research."* (Student 2)

"I was mainly focusing on industrial livestock production how this could benefit or lose for aiming to achieve certain SDGs because that is where I have my background and with what I am most familiar." (Student 11)

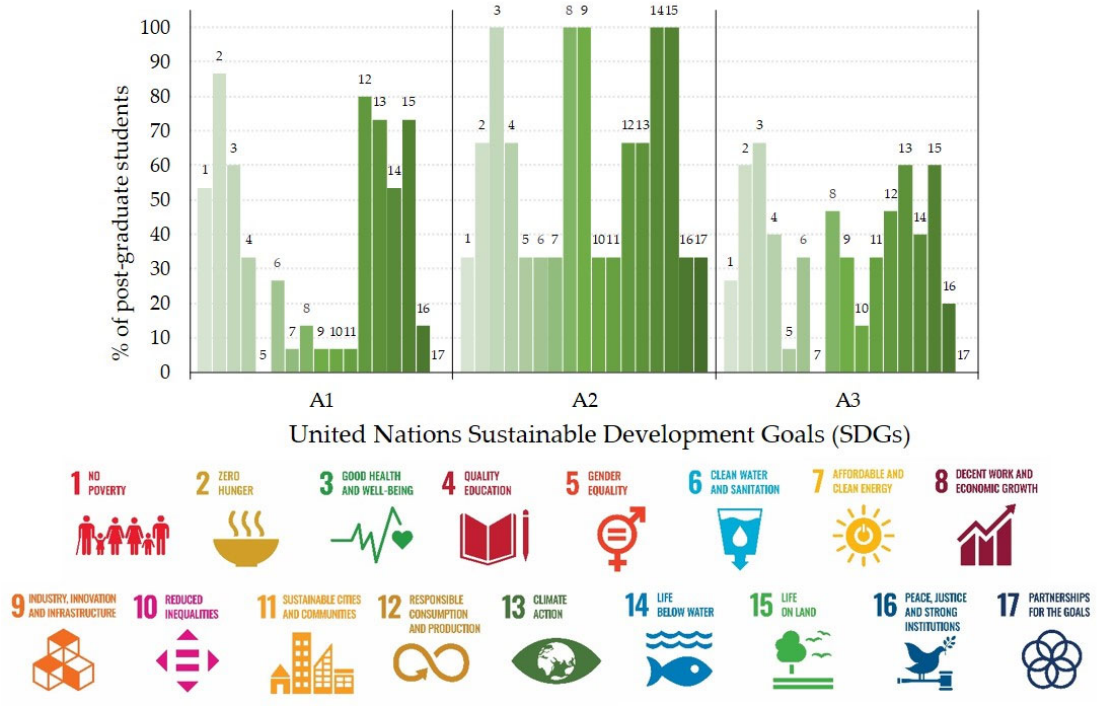

Figure 1. Percentage of postgraduate students (n = 15) finding a relationship between each of the 17 sustainable development goals (SDGs) and animal welfare (AW) across three-course assignments (A1 *pre-*, A2 *in-*, A3 *post-course*). The alternative answers were *yes* for the SDGs where a relationship was identified, and *no* if none was identified. The AW contexts (e.g., general in A1 vs. a defined context in A2 and A3) were different across the three assignments (A1—AW as a concept, thus without specific context and set as an individual *pre-course* assignment. A2—was a group *in-course* assignment with a specific AW case study on either livestock (cattle), working equines or companion animals (dogs) (each group, n = 5). A3—was an individual *post-course* assignment on the AW problem related to each student's PhD studies).

Even if participants were given the option to select as many SDGs in the A1 *pre-course* as they wanted, three students could not even identify the minimum of six SDGs and only one student selected more than the compulsory six that they were required to select before the start of the course.

"I found it hard to select six goals with most impact on animal welfare. Hopefully I will learn more about these connections during this course or maybe I will only be more confused but with much more knowledge (happy face)." (Student 3)

Most of their selections (e.g., SDGs 2: No hunger, 3: Good health, 12: Responsible consumption and production, 13: Climate action, 14: Life below water, and 15: Life on land) were dependent on problems or the rationale around food production (e.g., special diets, food shortages, farming, and livestock), natural resources (water resources, extreme weather, population growth trade-offs) health (zoonosis, antibiotic use, mental health) and social responsibility (food availability, food labels and fashion diets). Some participants explicitly indicated the direction and character of the relationship. However, in all cases, it was in the context of specifying potential conflicts between SDGs and AW. No synergies or positive reinforcement between AW to SDGs were explicitly stated. Still, they could be extracted indirectly from the narratives.

> *"Goal 7: Affordable and clean energy—Negative, Reasons: The facilities of energy use have a direct or indirect impact on animals. For example, the dam would limit the distribution and prevent migratory spawning of some fish species. Wind turbines and high voltage cable can be a huge risk for migratory birds...Goal 9: Industries, innovation and infrastructure—Negative, Reasons: same as previous one, infrastructure in transport, energy would cause damage to habitats and increase death risk."* (Student 9)

> *"SDG 3: Good health and wellbeing. Many diseases are zoonotic, which means they can be transmitted between animals and people. Good animal welfare is important to prevent this, as welfare-compromised animals are more prone to disease. Good animal welfare will also reduce the need for antibiotics, which is beneficial to prevent antimicrobial resistance. In addition, positive interactions and more active lifestyles with animals can contribute to increased human health and wellbeing."* (Student 5)

Even though A1 (*pre-course)* helped capture a wide variety of issues and problems, the selection of SDGs was relatively narrow (Figure 1) compared with selections made as a group in A2 (*in-course*, Figure 1 and Table 1) or where they reflected on their own research area in A3 (*post-course*, Figure 1 and Table 1).

Table 1. Participants (n = 5 in each group) finding a relationship between animal welfare (AW) and the SDGs. The students only noted when they identified a relationship (*). These are results from the *in-course* assignment (A2).

Group (G)	Associations Found between AW and the SDGs																
Assignment Topic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
G1: Livestock		*	*					*	*					*	*		
G2: Working Equines	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
G3: Companion Animals			*	*				*	*			*	*	*	*		

Nevertheless, it appears when forced to focus on a particular issue, participants at this summer school were sensitive to the particularities of the problem discussed and were able to find supportive or conflicting relationships between AW and the SDGs relevant to that context. For example (see Table 1), the students in group 2 (A2 *in-course*), who dealt with a case about working equines, argued for relationships between AW and *all* the SDGs. This was mainly based on the indirect effect the welfare of the animal has on the owner/caretaker's family, as well as the social, economic, and environmental impact. Groups 1 and 3, however, were not able to select such a wide range of links within their cases, even if they were encouraged to find as many associations between AW and the SDGs as possible, direct or indirect.

Notable, however, was that when working with a specific problem (A2 *in-course*), all participants found new AW—SDG relationships compared to those they had reported previously (A1 *pre-course*). The biggest change was seen in SDG 8: Decent work and economic growth and SDG 9: Industrial innovation and infrastructure, which changed from only two participants selecting them initially, to all participants selecting them in their case study analysis. Even SDG 5: Gender Equality and SDG 17: Partnerships for the goals that nobody identified initially were later identified by the five participants in Group 2 (See Table 1 and Figure 1). The total number of SDGs with links to AW identified by the students increased from A1 *pre-course* to A2 *in-course* and A3 *post-course*, even if the individual percentage for each SDG did not rise in all instances (Figure 1).

When participants were asked to identify AW—SDG relationships within the context of their own research project (A3 *post-course*), we noted that the type of selected SDGs did not change when compared with A1 *pre-course* (still mainly SDGs 1: No poverty, 2: Zero hunger, 3: Good health and wellbeing, and 4: Quality education, and SDGs 12: Responsible consumption and production, 13: Climate action, 14: Life below water, and 15: Life on land); yet the total percentage of participants finding an association in more rarely selected SDGs (especially SDGs 8: Decent work and economic growth, 9: Industry, innovation and

infrastructure, and 11: Sustainable cities and communities) increased (Figure 1). This is illustrated by the following quotes.

> *"…in conclusion, (I have) become aware of what is the most pressing common challenge for our society and (how to) try to figure out what actions should I take in my daily research and life is the best part of the course."* (Student 9)

> *"Encourage us to think outside of an animal welfare science "box"—since most of what we ended up discussing were social/societal issues."* (Student 5)

3.2. Rating Comparison between Participants at the Graduate Summer School (A4) and the Previous Workshop

For this exercise, it is important to note that participants needed to rate the link between AW and each SDG in both directions. As not all students had previously found links between AW and all SDG, many expressed apprehension in having to do this. Regardless, the students reported an overall mutually beneficial relationship between AW and the SDGs. However, the impact of achieving the SDGs on AW was considered to be stronger (mean score = 1.64) than the impact of improving animal welfare on achieving the SDGs (mean score = 1.02). Comparable ratings by experts, reported previously, were 1.15 and 0.89, respectively. Thus, in addition to being generally more positive about the beneficial relationship, the students more clearly considered the effect of the SDG on AW as being stronger, with none being stronger in the reverse direction (Figure 2).

This overall more positive rating of the strengths of the interactions and the greater emphasis on the impact of the SDG on AW by the students is seen even more clearly in Figure 3, where the plot is generally moved upwards on the y-axis compared to the equivalent plot by the experts. The overall impression is that the relative locations of the SDGs on the two plots are rather similar, but some differences were significant: compared to the experts, the students rated the effect of achieving the SDG on improving AW (i.e., a movement in the vertical axis) to be stronger for SDG 4: Quality education ($U = 23.5$, $p = 0.001$), SDG 11: Sustainable cities and communities ($U = 33$, $p = 0.005$), SDG 12: Responsible consumption and production ($U = 45$, $p = 0.03$) and SDG 13: Climate action ($U = 36.5$, $p = 0.009$). There were also trends for a stronger rating for SDG 14: Life below water ($U = 53.5$, $p = 0.078$) and SDG 15: Life on land ($U = 51.5$, $p = 0.064$). When rating the effect of improving AW on achieving the SDG (i.e., a movement in the horizontal axis), then students tended to rate a stronger effect of AW on SDG than the expert for SDG 10 Reduced inequalities ($U = 52 - 3$, $p = 0.07$).

In summary, both groups rated the same SDGs as being mutually reinforcing (e.g., SDG 12: Responsible consumption and production, 14: Life below water and 15: Life on land are higher up to the right in the plot). Still, there are others, e.g., SDG 8: Decent work and economic growth and 2: Zero hunger that were considered less strongly linked by the students, moving down and to the left in the plot. That is to say, while still on the same 45-degree angle, the range of the blue dots (mutually reinforcing SDG-AW links) is more spread out in the student plot compared to that of the experts. Both students and experts rated SDG 7: Affordable and clean energy and 9: Industry, innovation and infrastructure as having the weakest mutual impact, and these were the SDGs closest to the origin of the plot. The other consistent SDGs (SDGs 10: Reduced inequalities, 11: Sustainable cities and communities and 13: Climate action, coloured grey in Figure 3) which had previously also been identified by the experts as having a low impact, were moved upwards and to the right in the student plot, to be positioned among the mutually reinforcing SDGs (coloured blue). Perhaps the most noticeable difference between the two types of stakeholders, however, is in the ratings for SDG 4: Quality education. Although experts rated this as an enabling/reinforcing SDG (yellow dots in Figure 3a), the students considered this asymmetry to be very much stronger, resulting in SDG 4: Quality education now being high up on the left of the plot (Figure 3b).

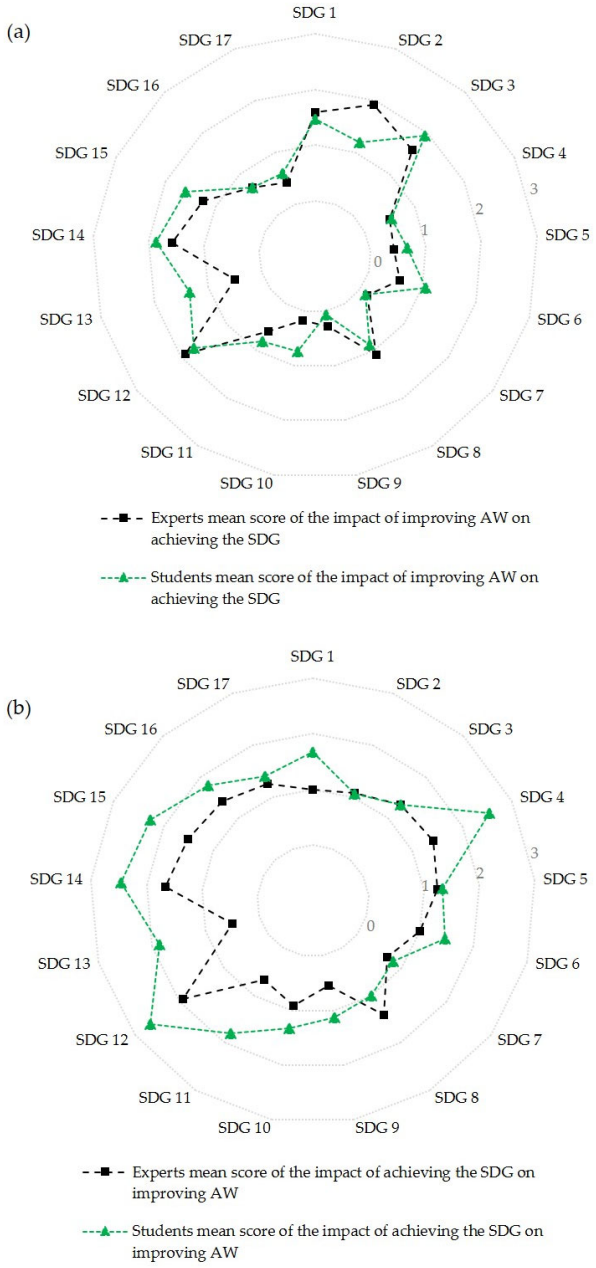

Figure 2. Comparative overview of the average score for each SDG-animal welfare link of two different sets of participants (experts n = 12, students n = 15). (**a**) shows the comparison of scores related to the impact of AW on achieving the SDG, where the black squares refer to the experts mean score and the green triangles refer to the students mean score. (**b**) shows the comparison of scores related to the impact of the SDG on achieving improved animal welfare, where the black squares refer to the experts mean score and the green triangles refer to the students mean score. Participants rated the association on a 7-point scale from indivisible (score +3) via reinforcing (+2), enabling (+1), consistent (0), constraining (−1) counteracting (−2) to cancelling (score −3). However, the mean scores range between the 0 and 3 values.

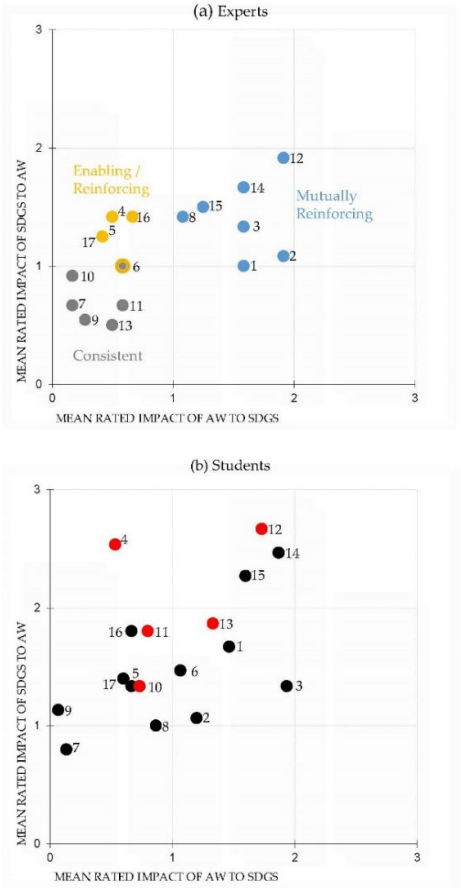

Figure 3. Scatter plot of the mean rated impact of SDGs to AW (y-axis) vs. mean rated impact of improving AW have on the SDGs, focusing on the top right quadrant. (**a**) shows the rating of a group of experts (n = 12) (from Keeling et al. [20]), whilst (**b**) shows the rating of a group of post-graduate students (n = 15). Three main groups of SDGs were found in (**a**) namely, the consistent group (grey dots), the enabling/reinforcing group of SDGs (yellow dots) and the mutually reinforcing group (blue dots). However, such groups are not as evident in (**b**) where a displacement upwards created a different organisation. The red dots in (**b**) indicate where significant differences (p-value < 0.05) were found between the rating groups (experts vs. students), these includes SDG 4: Quality education, SDG 10: Reduced inequalities, SDG 11: Sustainable cities and communities, SDG 12: Responsible consumption and production and, SDG 13: Climate action. Participants rated the association on a 7-point scale from indivisible (score +3) via reinforcing (+2), enabling (+1), consistent (0), constraining (−1), counteracting (−2) to cancelling (score −3).

3.3. Assessment Exercise (A5)

Of the four student working groups in this assignment, two selected SDG 12: Responsible consumption and production. In contrast, the other two groups selected SDG 8: Decent work and economic growth and 14: Life below water, respectively. Yet on the final rating 13/15 participants agreed that improving AW would have the greatest impact on the overall Agenda 2030 via SDG 12 and that moving towards this goal would do most to improve the welfare of animals. This was the case, even though this SDG showed a decreased frequency of selection from A1 to A3, *pre-*, *in-* and *post-course* (see Figure 1).

The summary of their arguments described this SDG as being a bridge between micro-level (person/individual) and macro-level (industry/trade, institutions/societal and government/legislation) actions with an impact on AW. This bridge applied whether the animals were goods (e.g., food-producing animals and laboratory animals), an aspect of biodiversity (e.g., wildlife) or part of a community (e.g., companion animals and working

animals). These micro and macro-level actions became crucial modulators of what defines a sustainable and fair society in the broader sense; meaning the physical, economic, and social elements and their relationships were all considered equally.

> *"If the quintessence of goal 12 [Responsible consumption and production] 'Doing more and better with less' goes along with an improvement of animal welfare might be questionable at first sight. Considering animal production, this could be translated as higher milk yields, faster-growing pigs or hens laying two eggs a day while feeding on the same ration. This increase in production traits would impair fitness traits of farmed animals (and thus compromise animal welfare), as breeding to promote both goals is simply just not possible (by conventional means). And if this was the case, it would absolutely not meet the goal definition of "responsible production and consumption". When it comes to animal products, I think there is no need to do more, only better. So, my interpretation is that we should have more of better animal husbandry systems with less edible resources being used and much less conventional animal production systems with all their negative impact on welfare and ecology. Better quality husbandry systems could pose a chance for farmers to gain better income with their products as they are maybe not forced to produce as much quantity as possible to earn a living. Again, there would be a strong need to educate people in the sense of what represents a sustainable lifestyle."* (Student 1)

4. Discussion

The purpose of this study was to investigate further the results from a previous study analysing the relationship between animal welfare (AW) and the 17 United Nations (UN) Sustainable Development Goals (SDGs) [20] and to elaborate on the impact of targeted education on a group of postgraduate students.

Overall, the analysis of the relationships between AW and SDGs in this study showed similar results to the original study, in that students identified a multitude of relationships between AW and SDGs. Initially (A1 *pre-course*) students identified the perhaps most obvious relationships (SDGs 1: No poverty, 2: Zero hunger, 3: Good health and wellbeing, 12: Responsible consumption and production, 13: Climate action, 14: Life below water, and 15: Life on land). The variation between students was expected given their various species expertise and our wide definition of animal welfare. Still, they had difficulties relating to a broader relationship between AW and the SDGs. However, after discussing and reflecting upon the issue from various perspectives, additional relationships became clear for the students (A2 *in-course* to A3 *post-course*) (See Figure 1 and Table 1). Assignments 2 (*in-course*) and 3 (*post-course*) were similar, in that they each dealt with a specific AW case, but they involved a progression in the students understanding of the level of relatedness between AW and sustainable development.

Thus, even if the results produced in A1 *pre-course*, A2 *in-course* and A3 *post-course* are not totally comparable, they portray a progression in students' understanding when they reflected on a particular AW problem (A2 *in-course* and A3 *post-course*) vs. AW as a big picture concept for all categories of animals (A1 *pre-course*). In the group assignment (A2 *in-course*, see Table 1) the students inspired each other to see additional relationships, and group 2, which reflected upon working equines, managed to find AW connections to all the SDGs. This might be a result of the fact that equines can be seen both as working animals and companion animals at the same time, thus relating to the SDGs more broadly. Although this would need confirming as only one group discussed each case. This assignment highlighted SDGs 3: Good health and wellbeing, 8: Decent work and economic growth, 9: Industry, innovation and infrastructure, 14: Life below water and 15: Life on land, which all three groups identified as relevant, and a new link was also found for SDG 4: Quality education. It seems that studying and reflecting upon more detailed and specific cases opened new perspectives and helped the students to see new links. Furthermore, they found that the links seen are context dependent and specific.

We interpret this broadening to be a result of the different lectures and different approaches (e.g., ethics, systems thinking, economics) that they were exposed to during the course. The environment was also conducive to a deep discussion, i.e., a product of the different levels of expertise and multidisciplinarity of the group, yet all working with a similar aim. Since 2005 the UN has the initiative of Education for Sustainable Development, and it is emphasised that the necessary "competencies cannot be taught but have to be developed by the learners themselves" and that they are "acquired during action, on basis of experience and reflection" [28]. When mixing individual reflections, lectures, and group discussions based on their own and other's experiences, an atmosphere was created that facilitated a broader understanding and cross-cutting conclusions.

In the rating assessment (A4) the students did the same assignment as previously done by the experts [20] (see Figures 2 and 3). Although both groups were small and should not be considered representative of their respective stakeholder categories of researchers and students, the two groups shared the positive vision of synergies across the two agendas, i.e., SDGs 12: Responsible consumption and production, and 14: Life below water at the top right (high impact) and 7: Affordable and clean energy and 9: Industry, innovation and infrastructure at the bottom left (low impact), but on looking closer it could be seen that these synergies were grouped differently, i.e., not in the same mutually reinforcing, consistent and asymmetric classes as previously. The biggest differences between the two groups (see Figure 4) were found in the relationship of AW to SDG 13: Climate action (from consistent to mutually reinforcing), SDG 11: Sustainable cities and communities (from consistent to enabling/reinforcing) and, the most obvious, to SDG 4: Quality education (from enabling/reinforcing to enabling/indivisible). Less conspicuous, but still statistically significant, was the difference for SDG 12: Responsible consumption and production (from mutually reinforcing to mutually indivisible).

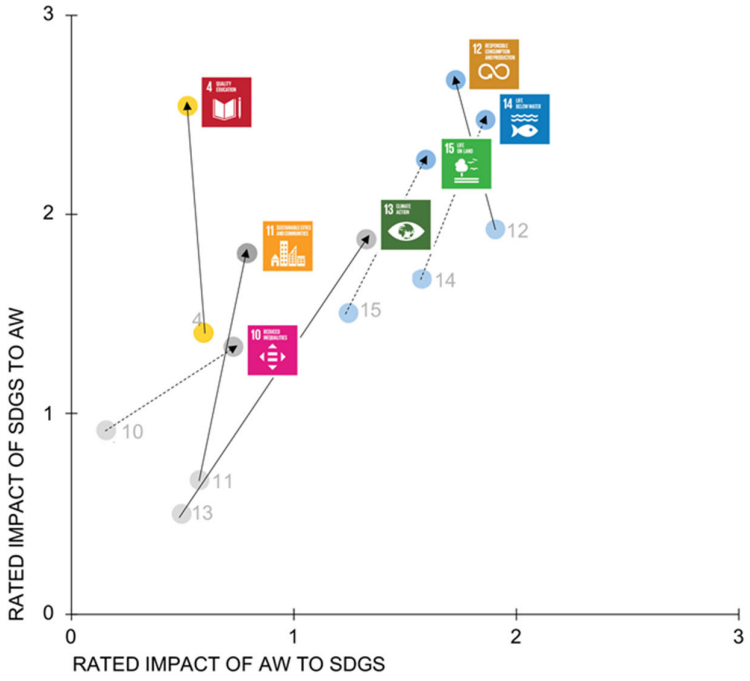

Figure 4. Scatter plot of the rated impact of SDGs on AW (y-axis) vs. Rated impact of improving AW have on the SDGs, (x-axis) focused on the top right quadrant. The figure merges the results from Figure 3a, b for those SDGs that differed significantly (full arrows) or showed a strong tendency (dotted arrows). The arrows point from the results of the researchers towards the results of the students.

The students put more emphasis on the effect of the SDGs on AW than on the impact of improving animal welfare on achieving the SDGs. The comparable ratings by experts, although numerically lower, were proportionally a bit more in favour of the effect of AW on the SDGs. This may reflect the researchers' greater experience with animal welfare, although it may also reflect a positive bias towards the importance of the subject. In that case, the students would be considered less influenced by their research environment and subject. The differences in how they reflect upon the task may also have impacted the results. Whilst experts positioned themselves in a professional role in the exercise, with an active knowledge of the things to be considered, the dominant view for the students was more the vision of themselves as a citizen with a responsibility to take part in solving the issue. These students are at the start of their careers and may see education as transformative and in a more idealistic way than experts, whose views have been shaped by their career. Such an interpretation would imply that the results are influenced more by what stage of life you are in than by what stakeholder group you represent.

The differences between the researchers and the students could also possibly be explained by the contemporary media attention on climate change, global overconsumption, and the increased pressure of urbanisation on the resources, as well as biodiversity loss, i.e., SDGs 13: Climate action, 12: Responsible consumption and production, 11: Sustainable cities and communities, 14: Life below water, and 15: Life on land (ordered based on the magnitude of difference). Furthermore, the students were much more optimistic about the role of education in improving animal welfare than the experts. Perhaps this could be a result of the fact that during the course, they were exposed to several lectures related to education for sustainable development. Although it could also be that researchers were more pessimistic about the extent, to which knowledge alone changes attitudes.

In the last assignment (A5 *assessment*), the students selected the SDG they considered would make a real difference to sustainability. Almost all students in this exercise chose SDG 12: Responsible consumption and production, as the aims of AW are closely aligned with responsible production of animals as well as the production of plant- and animal-based food for animals. The alignment between AW and the entire animal products supply chain provides opportunities for reducing the impacts of food production that are harmful to humans and the biosphere. AW practices that simultaneously reduce the harmful impacts of production can influence consumer food choices through standards, certification and marketing to create a self-reinforcing system of improvement that will result in responsible production and consumption. In contrast to the choice made by this group of students, SDG 17: Partnerships for the goals is given most attention in voluntary national reviews (VNRs) [29,30] and in another survey of 85 diverse experts, it was SDG 10: Reduced inequalities that was given the highest score [31]. In this study, we especially reflected upon livestock, working equines, and companion animals, but it would be of interest also to consider other animal groups, for instance, wildlife, addressing different aspects of AW. Both the students and the researchers highlighted the "biodiversity" SDGs, namely SDG 14: Life in water and SDG 15: Life on land and, interestingly, both researchers and students found "Life in water" to be slightly more relevant than "Life on land".

Since the course, several reports have been published concerning the status and trends within biodiversity, in particular the rapid decline in wildlife populations [12,13]. This decrease is due to changes in land and sea use, species overexploitation, invasive species, disease, pollution and climate change. Today only about 8 species of birds and mammals constitute more than 95% of the human food supply from livestock, future food security calls for more diversity [13] and many local breeds are on the brink of extinction [12,14]. The decrease in wildlife populations and the number of local breeds is mainly a consequence of increased demand for animal production. Acknowledging the link between the SDGs and AW and including it in the development of future production systems is likely to be of high importance when it comes to the future for conservation and sustainable use of both wildlife and local breeds. Such reflections need to be elaborated in future studies investigating the relationships between AW and the SDGs, and it would be

valuable also to establish the impact of such reports on the reflections of students and other stakeholder groups.

The course can also be considered from an Education for Sustainable Development perspective (ESD) that is a holistic and transformational approach to education, which addresses learning content and outcomes, pedagogy and the learning environment. It achieves its purpose by transforming society [26,28,32]. Within university education, there is a need for a balance where each course should provide professional insights in the academic subject and at the same time develop individual transformation within the student towards critical thinking, social awareness, justice, diversity, interdisciplinary perspectives, and sustainable development. However, the focus in most university course curricula and of the teachers is often on the subject-specific knowledge required for a specialised discipline. In general, individual courses are not developed to deliver an understanding of the "bigger picture" or how specialist knowledge from different disciplines contributes to that understanding. However, to solve global problems of sustainable development there is a need for a holistic perspective based on interdisciplinarity and practice in the application of critical thinking to complex social and ecological problems as a progression through university training.

Apart from the subject-related knowledge, there is also a need within university training for a progression in broader perspectives on sustainability and transformative learning. We argue that the format of this course offered learning opportunities to practice and develop critical awareness. Assignments 2 and 5 were forms of collaborative learning through social constructivism [33]. Other areas of EDS [28] that were introduced during the summer school (written in italics) were to empower students to *make informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations*, while respecting cultural diversity. We believe this course especially resonates with the overarching need of developing the critical thinking abilities of students [26]. We did so by enabling wider reflections concerning the influence of their research on the "bigger picture".

5. Conclusions

This study confirms a previous exercise showing that there are links between AW and the SDGs and that these are mainly synergies rather than conflicts [20]. It also showed that the individual evaluations of the links are influenced by personal experience and the context in which the links are evaluated. For example, initially, the students identified links between AW and SDGs for a limited number of SDGs, but during the later stages of the course, they saw links with practically all SDGs. Furthermore, these postgraduate students were, in general, more optimistic than the researchers in the previous study when it came to the influence of the SDGs on AW, and especially when it came to the SDGs 13: Climate change, 11: Sustainable cities and communities, 4: Quality education, and 12: Responsible consumption and production. In the final assessment activity, they identified SDG 12 as the most important goal, as it is an SDG to which everyone can contribute. Although in both studies, SDGs 12 and 14: Life below water were rated as having the strongest mutual synergies. In the future, it would be interesting to elaborate on the importance of the individual targets within each SDG, using the rating methodology developed here, and to compare more categories of stakeholders than the two used so far.

In this study, we have added another stakeholder category (students) and made the context for reflections more specific. In that process, we developed a methodology that encouraged students to have a more critical view of their own project—how it relates to global problems, and the tensions between SDGs that their project touches upon. At the personal level, these students all reflected on their individual contribution to science and as a global citizen in relation to contributing to sustainable development. The results illustrated an evolution of thought and a personal realisation that AW touches directly and indirectly in many dimensions beyond the animal component itself and, because of that, there were many synergies with the wider UN agenda.

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