

# Classroom Animals Provide More Than Just Science Education

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Published online: 25 February 2017  
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**Abstract** Keeping classroom animals is a common practice in many classrooms. Their value for learning is often seen narrowly as the potential to involve children in learning biological science. They also provide opportunities for increased empathy, as well as socio-emotional development. Realization of their potential for enhancing primary children’s learning can be affected by many factors. This paper focuses on teachers’ perceptions of classroom animals, drawing on accounts and reflections provided by 19 participants located in an Australian primary school where each classroom kept an animal. This study aims to progress the conversation about classroom animals, the learning opportunities that they afford, and the issues they present. Phenomenographic analysis of data resulted in five categories of teachers’ perceptions of the affordances and constraints of keeping classroom animals.

## 1 Introduction

Many primary classrooms have a classroom animal (Hummel and Randler 2010, 2012). Keeping classroom animals has the potential to enhance teaching and learning in primary science education in ways not available from books and other media (Wagoner and Jensen 2010), such as a deeper understanding of particular animals preferred habits and behavior. However, this potential may be restricted due to a teacher’s perception of the value of keeping an animal and their capacity and inclination to connect this animal to science concepts and skills, ethical considerations, and potential for humane education. Conversely, the potential of keeping classroom animals may be restricted if teachers fail to anticipate the costs associated with keeping classroom animals.

The focus of this article is primary teachers’ perceptions related to the practice of keeping classroom animals, particularly the benefits and the costs. At the study site, each classroom

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maintained a live animal, ostensibly as a vehicle for integrating science learning into general classrooms. Nineteen participants were questioned about the classroom animals in the context of a broader interview about the school's science program. Interview excerpts pertaining to the classroom animals were subject to phenomenographic analysis revealing five distinct categories of description regarding participants' perceptions of the phenomenon of animals in classrooms.

This article sets out the background relating to this study, such as current trends in education and the role of animals in science education and education relating to building an understanding of compassion and respect for people and animals, usually referred to as humane education (Boyer 2014). It outlines the theoretical framing of phenomenographic research and its relevance to this study. The methodology describes the conduct of this phenomenographic study and the resulting categories are illustrated by excerpts from the interview transcripts. Finally, implications of the findings arising from the study are discussed.

## 2 Background

This study focuses on teachers' reported perceptions; because research into teacher innovation and change and resistance, curriculum implementation/enactment, and educational technology suggests that teachers' perceptions influence how resources such as classroom animals are used. "[T]eachers' conceptions have a strong influence on how they teach" (Wan et al. 2013, p. 2953). Grundy (1987) claimed that teachers were not merely conduits of implementation of curriculum but rather the medium through which curriculum is enacted influenced by their knowledge and dispositions, which enable them to shape the curriculum to fit their students' needs. Braun et al. (2011) discussed the "role of context in forming, framing and limiting interpretative and practical responses to policy" (p. 581). At the study site, the provision of classroom animals in every classroom was a school policy implemented as part of a school-wide science program. Many factors might influence how an individual teacher enacted this policy, including how the policy and program are perceived, how the policy is resourced and monitored, and how it interacts with other school and government policies and practices (Braun et al. 2011). In the analysis provided in this article, we focus on teachers' understandings of purposes for which classroom animals might be used and their perceptions of the subsequent advantages derived from their presence.

Traditionally, science education has focused on knowledge of scientific concepts and processes which may influence teachers' perceptions of the place or value of animals in their classrooms. However, the contemporary view of scientific literacy also incorporates an appreciation of the nature of science and scientific practices (Campbell 2012) and the broader considerations that come into play in relation to socio-scientific issues, such as emotions and ethics (Sadler 2004).

### 2.1 Research into Keeping Classroom Animals

Numerous studies have identified classroom animals' potential contribution to science learning, including supporting learning about the nature of science, enhancing attitudes towards science, and developing scientific skills (Howes 2008; Morrison 2009; Rop 2008; Howes 2008; Hummel and Randler 2010, 2012; Meadan and Jegatheesan 2010; Sorge 2008; Wagoner and Jensen 2010; Zasloff et al. 1999). Morrison (2009) asserted that "[o]f course, observing live animals and learning their habits or particular needs is important ... [and] can teach something of the process of science" (p. 95). Similarly Rop (2008) reported that keeping crickets in the classroom enabled

children to “learn about the process of scientific inquiry that includes observing and recording skills, representing data in charts and graphs, the importance of using averages (means), and how to analyze data using mathematics” (p. 240) whereas Sorge (2008) advocated the keeping of classroom animals because of their capacity to engender positive attitudes to science.

Other researchers have demonstrated that interactions with animals can be beneficial for children in a number of different ways such as emotional comfort (Kaminski et al. 2002; Meadan and Jegatheesan 2010; Lewis 2007; Svensson 2014; Boyer 2014) and ethical values (Meadan and Jegatheesan 2010; Nicoll et al. 2008; Roy 2011). Meadan and Jegatheesan (2010) referred to the emotional comfort young children gain through relationships with animals, providing companionship, supporting a child in times of emotional stress, and enhancing children’s social-emotional development. Kaminski et al. (2002) investigated the role of animals in supporting the emotional health of hospitalized children. Their results indicate that animals could be influential in making settings more home-like and hence strengthening connections between the classroom and the wider community. Boyer (2014) claimed that “many researchers have continued to empirically identify the benefits of this [human-animal] bond as a catalyst for increased socialization and self-disclosure, as an aid to independence, as a sympathetic nonjudgmental ear, as contact with nature, and as a preventative measure to avoid alienation and loneliness” (p. 44).

Classroom animals may serve a role in humane education which is designed to “nurture respect, kindness, empathy and positive attitudes to people and other animals” (Nicoll et al. 2008, p. 45). Daly and Suggs (2010) reported that teachers believed that classroom pets increased student compassion and empathy, making a contribution to students’ socio-emotional development and also their academic development. They claimed that “[t]he ultimate goal of humane education programs is to foster compassionate values such as integrity, honesty and mercy” (p. 102). The obvious relevance of animals to science education (Daly and Suggs 2010) can mean that other potential value and issues involved in keeping a classroom animal can be overlooked. Yoon (2002) probed primary students’ pre-conceived ideas about human-animal relationships and reported that the students were aware of, and concerned with, the mistreatment of animals. Yoon advocated “teaching from a deep ecological perspective [placing] ... less emphasis on strictly content-oriented curriculum and more on attaining a critical understanding of the underlying causes of environmental issues” (p. 452). In addition she claimed that “encouraging a more biocentric science and technology curriculum requires a shift on the part of science teachers towards developing a pedagogy that embraces a deep ecology world-view” (p. 452). This article examines the potential value and issues of keeping classroom animals through the lens of the participants’ reported experiences and perceptions.

Much of the existing literature on the keeping of classroom animals focuses on educational benefits, with very few authors reporting on the associated costs and considerations for minimizing these. The analysis provided in this article not only builds on existing understandings of the benefits but also provides an analysis and illustration of the associated costs and potential negative impacts.

## 3 Method

### 3.1 Context of the Study

Participants in this study are drawn from one regional Australian primary school which had implemented a school-wide science program. The school had received funding to appoint three

classroom teachers with 0.5 load science specialists who engaged in professional learning to run weekly science lessons across the school. The documentation and evaluation of the implementation of this initiative was the focus of a larger study. One aspect of the implementation of the science program was the inclusion of an animal in every classroom for the generalist teacher to utilize as a resource for the children's learning. Classroom teachers were required to select from a list, such as scorpion, stick insect, lizard, and fish to name just a few. The study site school is unusual in that the inclusion of classroom animals was a school-wide initiative rather than the more usual practice of animals introduced to classrooms in an ad hoc manner, driven by the interests of the particular classroom teacher or opportunities presented by students' families. Teachers were given the freedom to utilize the presence of the animal in their classroom in whatever manner they considered appropriate and were supported in the care of the animal by a team of children designated "zookeepers."

The Australian Curriculum (AC) requires primary schools to support science learning outcomes for all primary students (Australian Curriculum, Assessment and Reporting Authority [ACARA] 2015). The AC highlights the place of science in our culture and daily lives and emphasizes its potential to assist people to make sense of the world around them. It stressed the importance of an understanding of science in making informed decisions about local, national, and global issues and the opportunity to engage in science-related careers. Awareness of the emphasis in the AC on making sense of the world may have impacted on the way the animals were perceived by the participants, particularly with regard to what opportunities were anticipated and taken when they were required to have an animal in their classroom.

The school-wide implementation of locating animals in all classrooms offered an ideal opportunity to inquire of diverse responses to and opinions of this phenomenon. The 19 participants included the principal, 3 science specialist teachers, 8 classroom teachers, and 7 university science students. The university student volunteers operated as classroom assistants who conducted science sessions with small groups of primary students under the guidance of the three science specialists. Each participant was interviewed for approximately 40 min and was asked about various aspects of the school-wide science program, including the classroom animals—what their experience with them had been, what they viewed the opportunities or benefits to be, and what they viewed to be the constraints or issues involved. Excerpts of the interview transcripts that referred to the classroom animals provided the data for a phenomenographic analysis focused on perceptions of keeping classroom animals.

### 3.2 Phenomenographic Analysis

Phenomenography is an interpretive approach that seeks to investigate the subjective experience of the world evident in the reported views and experiences of research participants. As an empirical research tradition, phenomenography does not proceed from a particular ontological position concerning the nature of reality, but it does support a view of knowledge as relational, dependent on context, and perspective and as bound up with reality rather than simply representing subjective realities. The aim of phenomenography is to reveal and describe variation in participants' perceptions of the phenomenon of interest, and most phenomenographic studies focus on the perception of a phenomenon as accessible through language (Svensson 1997). In this study, the phenomenon of interest is the keeping of classroom animals and perceptions are accessed via interview data. Phenomenography was chosen for its efficacy in exploring perceptions of a wide variety of phenomena, especially in educational contexts (Loughland et al. 2002). It contrasts with other possible approaches to

analysis in that, rather than seeking to describe differences between individual's perceptions of a phenomenon or differences between the perceptions of participant sub-types or the level of alignment between perceptions and actualities, phenomenography provides a mapping of the different categories of description that are evidenced within a diverse participant group as a whole. It seeks to establish an outcome space, which is a finite set of different categories of description of the perceptions of a phenomenon expressed by the group of participants. This results in "a description on the collective level, and in that sense individual voices are not heard" (Marton and Booth 1997, p. 114). "[A]nalysis [is] focused on key aspects of the collective experience" (Akerlind et al. 2005, p. 82), so the outcome space presents a focus on collective meanings (Akerlind et al. 2005). However, "[e]ach category is described ..., with a brief illustration of key aspects of the categories through verbatim quotes from relevant interview transcripts" (Akerlind 2005a, p. 146). The researchers' focus is thus on interpreting the participants' perceptions of the phenomenon, rather than the phenomenon itself (Marton 1981, 1986; Marton and Booth 1997).

Phenomenographic protocols (Akerlind et al. 2005) guided the conduct of the study:

- Data collection from a diverse group of the participants to canvas a wide range of perceptions
- All perceptions equally valued
- Immersion in the data
- Iterative development of categories and dimensions beginning with meaning statements

The final result of phenomenographic analysis is an outcome space, that is, a set of categories. The aim of the analysis was to examine the data and identify the full range of perceptions evident in participant interviews and to then organize them according to emergent theoretical distinctions.

### 3.3 Process of Phenomenographic Analysis

#### 3.3.1 *Meaning Statements*

The responses related to the keeping of classroom animals from all the participants were pooled. Thus, the examination of responses focused on what they might reveal about the way the participants perceived the keeping of classroom animals, considering of each utterance "what does this response tell me about their perception if they say .....?". Each utterance contributed to a list of *meaning statements* which are then grouped to form the initial categories (Herbert and Pierce 2013). For example, one teacher expressed the view that

... they [children] were interested in them at the start and now it's sort of like they were put there and it was like "You've got to look after it" ... like we're babysitting them, there's no real interaction.

This quote and others like it contributed to the meaning statement "Classroom animals are seen to be an inconvenience."

#### 3.3.2 *Development of Categories of Description*

Meaning statements were grouped to form the initial categories. For example, the meaning statement "Classroom animals are seen to be an inconvenience" was grouped with other

similar meaning statements, such as “Classroom animals are seen to involve a cost (emotional cost, time cost, financial cost, space costs)” to form an initial category which eventually became category D: “Classroom animals are perceived to be an added burden in the classroom.” The transcripts were repeatedly interrogated to facilitate accuracy of the researchers’ interpretation of the participants’ utterances, with the second author providing inter-judge reliability. She was able to classify statements from the transcripts relating to classroom animals according to the categories provided (Sandbergh 1997).

### 3.3.3 *Development of Dimensions of Variation*

The aspects of the phenomenon which appear important in distinguishing one category from another are called *dimensions of variation* (Akerlind 2005b). These are theoretical distinctions, determined by the researchers’ interpretations, in this case, common domains of educational practice, such as curriculum and socio-emotional development that distinguish the foci of different perceptions. The commonalities and differences between the categories were defined by the particular “attributes” of the dimensions which relate to a particular category. The task in establishing initial dimensions is to identify “different aspects of the phenomenon that were referred to in some transcripts but not in others ... [and] tentatively identify dimensions that appeared critical in distinguishing between transcripts and between emerging categories of description” (Akerlind 2005a, p. 122). Careful consideration of the data suggested the initial dimensions and associated attributes. This involved a systematic reading of each transcript and consideration of the initial categories with respect to the similarities and differences between them resulting in the identification of possible dimensions and their attributes. The categories and dimensions were re-examined several times and the transcripts were revisited repeatedly with a focus on how the keeping of classroom animals was perceived by the participants and less emphasis on what the participants in the sample did or said. This led to a clearer definition of the dimensions and the possible attributes that they could take.

### 3.3.4 *Finalization of the Outcome Space*

The dimensions emerged in conjunction with the categories and were refined in an iterative process along with the categories until no further refinement is possible. The final set of categories was called the outcome space (Akerlind 2005a).

## 4 Results

This section describes five categories evidenced in the participant interviews in relation to classroom animals (Table 1). Together, these comprise the outcome space. The categories represent a reduction of statements made by the interviewed participants that characterize the range of perceptions of keeping of classroom animals evident in the data. As described above, these categories emerge from a reading of the pooled transcripts from 19 participants. The categories are represented in Table 1 as five statements, labeled A to E.

The structure of the outcome space is established through the consideration of the attributes in the four dimensions of variation evident in the data: curriculum; socio-emotional; cost; and connections, each with multiple attributes of variation (see Fig. 1). Themes identified in teachers’ talk about the classroom animals exhibit variation in these dimensions, each

**Table 1** Primary teachers' perceptions of classroom animals

Category	Perception of classroom animals
Category A	Classroom animals are perceived to be valuable for science education.
Category B	Classroom animals are perceived to be valuable for humane education.
Category C	Classroom animals are perceived as an opportunity for cross-curricular learning.
Category D	Classroom animals are perceived to be an added burden in the classroom.
Category E	Classroom animals are perceived to provide opportunities for links to outside the classroom.

manifesting in a range of specific attributes. Expanding awareness of the factors influencing the efficacy of the animals in supporting children's learning, including constraints on their inclusion in their curriculum, is seen in the increasing number of dimensions and their attributes in the each category. In this way, the four dimensions delineate the five categories one from another.

The dimensions and categories explicate what emerged as the significant features of the classroom animal initiative when the reported views and experiences of all the participants are taken into account, with the categories emerging from our initial coding of the meanings of participants' statements and the dimensions representing our subsequent theoretical analysis. In the sections below, the categories are used to organize a description of the outcome space, with illustrative data provided for each attribute. The descriptions of category are each set out in the same way, beginning with a statement of the short label of the category, which is followed by a figure indicating which dimensions and associated attributes are in focus for the category. Not every instance of evidence for a category is included; rather, sufficient evidence is given to illustrate the nature of the category and confirm the category's existence in this particular data set.

#### 4.1 Category A: Classroom Animals Are Perceived To Be Valuable for Science Education

Data excerpts coded within this category suggest two dimensions of variation: "curriculum" and "socio-emotional." These dimensions manifested respectively as two attributes—"science" and "motivation"—as shown in Fig. 2. These attributes refer to different aspects of student engagement in schooling, firstly, cognitive engagement with the specific disciplinary content of science and, secondly, affective engagement with that content.

Perceptions in this category characterize the view that classroom animals were valuable for science education. When participants talked about the value afforded by the animals in relation to science (labeled "science"), they referred to opportunities to support the learning of the science curriculum as well as to the role played by the animals in motivating children to

<b>Curriculum</b>	<b>Socio/emotional development</b>	<b>Cost</b>	<b>Connections</b>
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

**Fig. 1** Dimensions and their attributes

Curriculum	Socio/emotional development	Cost	Connections
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

**Fig. 2** Attributes of dimensions in category A

engage with science learning (labeled “Motivation”). The keeping of classroom animals was described as providing an opportunity for learning scientific principles and processes as well as science content areas.

In the following example, the participant describes how classroom animals were the subject of an experiment, affording students with the opportunity to design an experiment, to undertake a program of observations and record keeping, and to make conclusions about the behavior of the animals. An experiment was designed to see where fish preferred to be in a tank. There were 12 small fish tanks set up by the children with rocks on one side of the tank and plants on the other and the position of the fish was observed at the same time each day.

Susie<sup>1</sup>:... they learnt how to set up a fish tank ... and they did a little experiment seeing where the fish preferred to be in the tank. ... also giving them an idea of how to set up an experiment, experimental design, you need replication.

In relation to motivation towards science learning, the animals were reported to motivate reluctant learners to be more engaged with science. The “motivation” attribute in the dimension “socio-emotional development” was expressed as being particularly relevant to students who might not otherwise or traditionally be interested in schooling or science (Hummel and Randler 2012).

Jane: we have these cool animals at school and the kids, like you know, might not be sort of engaged other ways, but love the lizards. Those boys that are 10 and 11 and don't really want to be at school but yet with the lizard, they're happy to watch the lizard and maybe write about the lizard and that sort of stuff.

## 4.2 Category B: Classroom Animals Are Perceived To Be Valuable for Humane Education

In this category, participants referred to classroom animals as providing opportunities to learn about animal ethics, considering such issues as animal rights (Department of Education of Western Australia 2002), especially for those children who had no previous experience with pets. In addition, classroom animals provided opportunities for children to develop attributes such as compassion and empathy which are applicable to all forms of life including human beings (Yoon 2002). Perceptions in this category refer to the value of classroom animals for humane education in its broadest sense, including animal ethics and the potential for wider applicability of compassionate values such as integrity, honesty, and mercy. The classroom animals provided an opportunity to teach about the knowledge, skills, and dispositions to live ethically, sustainably, and compassionately. When teachers talked about the value afforded by the animals in relation to humane education, they referred to opportunities to support the learning of ethics and foster socio-emotional development.

<sup>1</sup> Pseudonym



In Fig. 3, the shaded cells indicate which attributes of which dimensions are evident in the data and together provide evidence of the existence of this category. Interview excerpts coded into this category pointed to a complex array of attributes (see shaded cells in Fig. 3) that emerge when classroom animals are used to support humane education, including engagement with specific curriculum areas, aspects of children's socio-emotional development and affective engagement, such as grappling with the complex issues regarding death and dying, and the potential for learning which spans both science and humane education. The following quote illustrates these two attributes of "science" and "humane" in the dimension "curriculum." In this quote, the participant expresses the awareness of the dual nature of the learning opportunities afforded by the availability of a classroom animal, mentioning both science education and ethical issues related to humane education.

James: And I think also that they're being used for scientific observation and scientific purposes as opposed to be classroom pets. I think we were concerned about that ethical position of them being pets, but they are actually there for scientific purposes and I think the work that we've done with the axolotls<sup>2</sup> and the breeding program there – that's been really enlightening for the children. And sad when they can see axolotls die and the baby axolotls die – why is that the case? Well then they test the water and so suddenly out of some situation that was adverse comes all of these other questions which is science in real life.

For the dimension "socio-emotional development," all attributes are evident in this category as seen in the following quotes and the attribute "emotional" is found in the dimension "cost." Specifically the attribute "responding to disadvantage" is illustrated by the following:

Natalie: ... the opportunity to see and feel and observe changes in a live animal. Some of them don't even have kittens or puppies. ... also to be able to have the opportunity to take some responsibility. When they're handling them, how they handle them, all those sorts of things ... the responsibility of actually having a pet.

This interview excerpt exemplifies the attribute labeled "ethical":

Tim: Yeah I don't really like the idea of having the yabby in a tank, I think he'd be happier out living wherever he came from. And we've had conversations in the classroom about how we can make his life better and his habitat more appealing.

The attributes "personal development" and "emotional" are seen in the following:

Lynda: And sad when they can see the change of water can see axolotls die and the baby axolotls died ... And the fact that they can really look at life cycles. I mean the barramundi<sup>3</sup> are fed with live feeder fish so for the children to actually drop a little fish in and then watch nature take its course.

The attribute "motivation" is demonstrated by this quote:

Kathleen: We've got kids that come running through the door every morning because they want to hold one [of the animals]

### 4.3 Category C: Classroom Animals Are Perceived as an Opportunity for Cross-Curricular Learning

In this category, participants emphasized the opportunities that classroom animals present as a focal point for cross-curricular learning and development of children's

<sup>2</sup> An amphibian also known as a Mexican salamander or Mexican walking fish

<sup>3</sup> A fish also known as the Asian seabass, the Australian seabass, and the giant perch

Curriculum	Socio/emotional development	Cost	Connections
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

**Fig. 3** Attributes of dimensions in category B

socio-emotional education and motivation and the potential for learning which spans science and humane education with connections to other areas of the curriculum. Figure Fig. 4 illustrates those attributes of the dimensions which are discerned in this category and indicate the purpose of classroom animals is to provide learning opportunities for many areas of the curriculum, such as literacy, numeracy, and personal development.

The following quotes illustrate the attributes of “science,” “humane,” and “other” in the dimension “curriculum which is the primary focus of this category. They have been included because they illustrate ways in which the presence of the animals enabled cross-curricular opportunities such as reading, researching, writing reports, and enquiry learning.

Sally: We’ve got such a crammed curriculum that we just can’t cover in five hours literacy and maths and writing each week, so we have to actually integrate it [science] in there. So a science activity related to the animals might be put into our reading groups where it might be a research based project where they’ve got to go and find the information; work out the facts and details of that information and then it will be put into our writing program where they’ve got to write up a report.

Tim: One of the challenges was the crowded curriculum and the fact that we really didn’t want to see science sitting out there on its own as another specialist area. We wanted to see it as science [and the animals] having a real place in the total education program of the school and to have links to literacy and numeracy and to enquiry learning.

Lynda: I’m hopeful that the teachers do see it as an opportunity to bring literacy and numeracy and other social learning’s all together and seeing science as a vehicle for doing that. And even the creatures as a vehicle for doing that.

In addition, this focus on cross-curricular learning also includes elements of socio-emotional development. Comments related to the emotional cost of animals dying can be seen in these extracts from the transcripts.

Sally: ... they’re just waiting for their fish to die, it’s just been lying on the bottom of the tank for about four weeks, it doesn’t do anything, so it like, ‘oh is it dead yet’.

Curriculum	Socio/emotional development	Cost	Connections
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

**Fig. 4** Attributes of dimensions in category C

However, this adverse experience can be utilized as an opportunity for socio-emotional development. The following quote illustrates how a teacher might take an animal's death as an opening to explore issues related to death and dying.

Sally:... there's been a death of a mouse. So that's another thing which has actually been – you might see this as a negative but I see it as positive is it's been getting children getting used to death and the life cycle and stuff which is quite good.

This category is different from Category B because an awareness is demonstrated of the potential for motivation and connections with a wider range of curriculum areas. Both Category A and Category B focus on a particular learning area within the curriculum, whereas in Category C the focus is on the potential for cross-curricular learning that integrates more than one learning area.

#### 4.4 Category D: Classroom Animals Are Perceived To Be an added Burden in the Classroom

The fourth category introduces a new idea about classroom animals. In this category, the focus is on aspects of the cost of keeping an animal. The attributes of dimensions discerned in this category are highlighted in Fig. 5.

Cost factors were seen as significant constraints on the usefulness of animals in the classroom for promoting children's learning. The following comments illustrate the cost factors involved in keeping classroom animals expressed by the group of participants in this study. This data excerpt illustrates concerns about the monetary value of the animals and the infrastructure required for their upkeep being money which could be better spent on other initiatives.

Sally:... so much money has been put into animals in the school, it'd be good to see that they were actually used and recognized rather than just sit there as a pretty thing on the wall that needs to be rotated every term, because a lot of the equipment can't be. It's not just a matter of picking up an enclosure and moving it.

Some participants mentioned the care of the animal to be just one more thing added to their workload.

James: I remember thinking 'oh no', this is something else I'm going to have to remember to do. And this is my first year in grade 1/2 classroom for a long time. So at the beginning of the year I was thinking about a million things that I'll probably forget to do.

Sally:... that extra bit of worry in the back of my mind thinking, oh God I forgot to change that water or I've got to make sure I take something in tomorrow because I don't know whether the zoo keepers are going to come.

Curriculum	Socio/emotional development	Cost	Connections
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

**Fig. 5** Attributes of dimensions in category D

Other concerns expressed were about the impact on the children when animals die or what would happen to the animals during the holidays, thus coded under “inconvenience.”

James: ... so there's 5 Axolotl's that need to go to homes and nobody wants them.

These cost issues are highlighted in the following comments about sea monkeys.

Kathleen: We did have sea monkeys in a couple of classrooms to keep the costs down.

Kathy: Because I don't have a lot of bench space in here so I had to organize that I'd be able to have another table to put a tank that size. I could've got in early and said, "I'll have sea monkeys." They take up about a shoe box size kind of thing. But I thought if I'm going to have something, may as well have something that the children are going to be able to interact with.

Peta: I'd probably rather have something [other than sea monkeys] that they can touch and hold and observe the changes and that sort of thing ... I found it hard getting reading material with the sea monkeys that the kids could understand because it was quite in depth and there was a lot of scientific language in it.

Comments describing the ideal animal mainly focused on cost factors.

Kathleen: ... awake during the day, able to be handled, active, observable changes such as having babies or shedding skin, cheap to buy, house and feed and not take up too much space in a crowded classroom.

Lynda: The best animal is the giant cockroach because it doesn't cost much, only about \$80, doesn't take up much space, only needs a small tank [which she indicated with a gesture], doesn't need much care and doesn't cost much to maintain, only needs some dry leaves and a bit of moisture.

#### 4.5 Category E: Classroom Animals Are Perceived To Provide Opportunities for Links to Outside the Classroom

In category E (Fig. 6), participants referred to classroom animals as providing opportunities to link with the wider community in a variety of ways, such as excursions to locations of interest, discussing school work with parents or friends when not at school, or communicating with the school community through the school blog or newsletter or through the media.

Some responses alluded to opportunities for learning or discussing learning outside the classroom.

Kathleen: So when I turn up at the school there is often a group of children digging around in the garden trying to get worms to feed the animals.

The following quote indicates the dissemination of information about the animals out into the wider community.

Lynda: ... there's a lot of evidence around the school of things that are up on the wall to do with the creatures. It's a very, it's a highly visible program; it's each week almost in the weekly newsletter. The back page has got photos of the creatures and things written by students about, the ... had eggs or what the name of the frog is, or whatever it is that's happened. So it's, it's very visible... particularly the

Curriculum	Socio/emotional development	Cost	Connections
Science	Responding to disadvantage	Inconvenience	Wider community
Humane	Ethical	Financial	Home
Other	Personal development	Space	Out of class
	Motivation	Emotional	Cross curricular

Fig. 6 Attributes of dimensions in category E

teachers that have been involved in the PD to date, their students have made digital artefacts in relation to the creatures, and have put them up there [the blog].

Kathleen: If you look on the blog, Science is there, you can see the students work, you can see their animations they've made about different animals and their habitats.

The classroom animals are valued as a means of promotion of the school, not just as an educational opportunity.

Natalie: In terms of the school community, it's doing all sorts of work, in terms of the promotion of the school and profiling the school. Nearly every bit of publicity that goes out from the school mentions Science these days, their advertising to [kindergarten], to prospective students is all about Science. They had [kindergarten] students come in and they did a – they call it the creature crawl, they went from room to room and some of them handled some of the pets.

Lynda: ... kids going home excited talking about them [animals], parents talking about them so they're seeing all this positive stuff for the school. Something we can be proud of, something a bit unique cause what we're doing with the [university] is pretty unique working with the scientists [student volunteers] coming into the classroom every week not just a once off.

This category shows awareness that classroom animals may provide opportunities to link children's classroom learning to other aspects of their lives and surroundings.

## 5 Discussion

The potential benefits of classroom animals are often underestimated and associated with particular parts of the science curriculum. The results of this study provide insights into teachers' perceptions of a broad range of interrelated opportunities and costs, including a broader view of what domains of science curriculum might be supported (e.g. critical science education and animal ethics). The outcome space presenting perceptions of classroom animals reveals the diversity expressed by the participants about keeping animals in classrooms. The outcome space is structured by four dimensions evident in the data representing aspects of the phenomenon which differentiate one category from another. The attributes in the dimension of "curriculum" relate to the curriculum areas where participants considered the animals to provide opportunities for children's learning (Daly and Suggs 2010; Sorge 2008).

The attributes in the dimension of "socio-emotional development" deal with a complex array of issues that emerge when classroom animals are used to support humane education providing an opportunity to build children's pre-existing awareness and concern regarding the mistreatment of animals (Department of Education of Western Australia 2002; Yoon 2002). Constructivist, inquiry-based approaches to science education (Anderson 2002; Hackling et al. 2010), which position students' understandings at the center of learning, fall within an approach broadly known as critical science education and have the potential to increase the relevance of the curriculum to students' personal and local contexts (Smyth et al. 2008), increase the meaningfulness of learning activities through a critical engagement with curriculum content and processes (McInerney 2009), and speak to marginalized learners by offering a challenge to academic subjectivities that objectify knowledge and disavow links with students' lives and emotions (Kincheloe 2001; Bayne 2009). The incorporation of emotion and ethical debate into science curricula can facilitate links between school science learning—traditionally constructed as value free and emotionally detached—and informal science learning outside of school, which involves the affective domain and emotional responses such as fascination, wonderment, excitement, and disgust (Alsop 2002). The keeping of classroom animals was perceived by teachers to provide opportunities to leverage students' emotional

responses—as well as their interests in social and ethical implications of scientific knowledge and practice—in order to enhance students' engagement in science learning (see Lynch and Herbert 2015 for a detailed discussion of this aspect).

The attributes in the dimension of “cost” relate to various costs seen by participants as influencing the choice of animals and their effectiveness as prompts for children's learning. Considerations of financial, space, and emotional costs were expressed by this group of participants, indicating that care should be taken in the selection of animals as these factors are effected by the type of the animal. The cost factor of this addition to the many things that teachers have to consider was seen by some participants to be an extra burden that they would have preferred to avoid, whilst others embraced these additional responsibilities and embedded their classroom animal in many areas of their curriculum. Contrary to Daly and Suggs' (2010) finding “that most teachers had positive attitudes and experiences with pets in classrooms” (p. 110), many teachers in this study expressed concerns related to the aspects of seen in the “cost” dimension.

The attributes in the dimension of “connections” reflect the different ways the animals were reportedly used to make connections with other people and places outside the classroom and also connections across the curriculum to bring a more connected view of school learning (Bouillion and Gomez 2001). This dimension acknowledges links to children's learning outside the classroom and across curriculum areas and to the wider community in increasing awareness of environmental issues indicating a shift in pedagogy towards Yoon's (2002) deeper ecology worldview. The final category, category E, encompasses all the attributes in the dimension “connections” and recognizes the broad range of perceptions of keeping classroom animals and the multiple advantages of their inclusion in school classrooms.

Although, in the context of this school, the classroom animals were introduced primarily as part of a science specialism, participants were aware of many other potentials that they provided for engaging students, supporting student learning, and promoting other positive outcomes, together with a range of cost considerations that were involved and many other factors influencing the usefulness of their inclusion. This is consistent with Zasloff et al.'s (1999) view that “animals can be very effective for formal instruction in science and other subjects and for teaching humane attitudes and values, and can interest and motivate young students” (p. 355).

The data for this article came from semi-structured interviews from a broader study of the implementation of a science curriculum innovation at this school, of which the inclusion of classroom animals formed a part. In this study, classrooms were not observed nor was student data collected which could be used to evaluate the effectiveness of classroom animals in achieving certain perceived goals, for example, science content knowledge and skills or teaching about humane attitudes and values. These are both potential future lines of inquiry which could bring different perspectives into the issues involved in the keeping of classroom animals. The virtue of the analysis presented here—focused on an abstract description of the outcome space of teachers' perceptions of keeping classroom animals—is its attention to a diverse range of views and reported experiences and the structuring of these with reference to common domains of educational practice, such that the resulting outcome space might inform future consideration and decision-making about the keeping of classroom animals. As expressed by Svensson (1997, p. 168), this is consistent with the epistemological assumptions of phenomenography that value description—both participants' rich descriptions as a source of perceptions and the “abstracted, reduced, and condensed” phenomenographic descriptions that follow analysis and that see virtue in this reduction of rich data to a “limited and pregnant form.”

## 6 Concluding Remarks

The categories together summarize the concerns and opportunities of keeping classroom animals as expressed by the participants of the study. The inclusion of classroom animals in this school was mainly intended to enhance a science specialism, but the analysis demonstrates that participants were aware of the potential of classroom animals to engage students, to support student learning in a range of curriculum areas, and to promote other positive outcomes. In addition they reported other factors affecting the efficacy of classroom animals as a learning resource.

The outcome space brings together in a single framework the diversity of considerations to be contemplated by schools intending to introduce classroom animals. It provides information regarding the various sometimes competing aspects of their inclusion to make informed decisions in a cost/benefit analysis. Benefits articulated by the participants in this study include the value of classroom animals in enhancing the education of primary school children through increased understanding of the nature of science and scientific practices (Campbell 2012) and socio-scientific issues (Sadler 2004). The outcome space provides a tool for reflection to assist teachers understand, support, and articulate benefits of classroom animal initiatives.

Costs may be financial or related to classroom considerations such as space, inconvenience, and emotional cost. Financial costs are especially important in a time of constraints on budget allocations and the competing proposals requiring funding for curriculum innovations. The outcome space offers school leadership team's knowledge of the critical aspects of the innovation to further assist in deployment of a school's limited funds. The other non-financial disadvantages are also extremely important and care should be taken to limit these aspects in any initiative involving the introduction of animals to classrooms.

This study provides insights into considerations of the establishment of animals in classrooms in order to maximize the benefits for children's learning whilst also minimizing the disadvantages and costs.

### Compliance with Ethical Standards

**Conflict of Interest** No conflict of interest occurs with this article.

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