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Using games in environmental and sustainability education: identifying teaching traditions in a game about carbon dioxide emissions

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ABSTRACT

This study explores how the card game *Climate Call* and its associated educational materials, can support teaching about climate change and carbon dioxide emissions in upper secondary school as part of environmental and sustainability education (ESE). Using discourse analysis, the study examines the game and materials through three ESE teaching traditions: fact-based, normative, and pluralistic. The findings show that the game incorporates all three, with fact-based and pluralistic traditions being equally prevalent and normative slightly less so. The didactical tetrahedron framework is used to analyse the game's role in mediating interactions between teachers, students, and content. The game's versatility allows it to align with different teaching traditions and learning objectives, facilitating discussions, factual knowledge acquisition, and critical thinking. The study underscores the possibilities of educational artefacts such as games to shape learning activities and support ESE teaching. However, it concludes that the possibilities presented by such games are dependent on teachers' abilities to scaffold learning, relate content to broader sustainability issues, and engage students in critical discussions.

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Environmental sustainability education (ESE); ESE teaching traditions; didactical tetrahedron; games as educational artefacts; teaching about climate change

SUSTAINABLE DEVELOPMENT GOALS
SDG 4: Quality education

Introduction

Environmental and sustainability education (ESE) aims to prepare students to engage with complex sustainability challenges, like climate change. Within this field, selective teaching traditions such as the fact-based, normative and pluralistic offer different perspectives in how issues within this field are framed in an educational setting (Öhman and Östman 2019). In the European context, didactics is understood as the professional science of teaching, encompassing instructional methods and analytical tools for planning, implementing and reflecting on teaching (Hopmann 2007). A conceptual model used in this context is the didactical triangle consisting of teacher, student and content that has been developed into the didactical tetrahedron

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illustrating the interplay between artefact, content, teacher and student (Rezat and Sträßer 2012). An artefact in education can take many forms like textbooks, digital tools and games. Games in education has been frequently used and researched and there are a variety of games with environment, sustainability and climate change content (Reckien and Eisenack 2013).

The purpose of this article is to investigate how a card game as an artefact, like the game Climate Call, and the associated teaching material, with a focus on carbon dioxide emissions, can align with the three selective teaching traditions in ESE (fact-based, normative and pluralistic) and give an understanding on how a game can be used to support teaching about climate change in upper secondary school. The game is also viewed through the lens of the didactical tetrahedron to explore the relationship between the game as an artefact, content, teacher and student.

The research question is:

How does the card game *Climate Call*, and the associated teaching material, align with fact-based, normative, and pluralistic teaching traditions in ESE?

Following this introduction, the article proceeds with a background section that contextualises environmental and sustainability education and introduces the selective teaching traditions (Öhman and Östman 2019) in environmental and sustainability education (ESE). This is followed by the introduction of some research on how climate change and carbon emissions have been taught in school. This section then explores educational games as artefacts for learning and introduces the game Climate call before continuing with a short introduction of the northern European concept didactics and the didactical tetrahedron. The article moves on describing the method and presents the findings that emerged from the analysed material. Finally, in the discussion, the findings are interpreted using both the framework and the didactical tetrahedron and considered from a teaching perspective.

Background

Environmental education in Sweden

In this study a card game and its associated teaching material first developed in Sweden is examined. In the Swedish context, environmental education has been a part of the curriculum since 1950 (Björneloo 2007; Breiting and Wickenberg 2010). Initially focusing on nature conservation, environmental education (EE) has evolved into a broader framework of education for sustainable development (ESD) and environmental sustainability education (ESE), addressing global environmental, social, and economic issues, and becoming integrated with climate change education (CCE) (Grosseck, Țîru, and Bran 2019; Sund and Gericke 2021). ESE may be viewed as encompassing a broader scope than ESD, focusing not only on sustainable development but also on the intrinsic value of nature and ecosystems, emphasising the interconnectedness of environmental, social, and economic systems, and promoting a holistic understanding of sustainability issues (Hume and Barry 2015; Van Poeck and Östman 2021; Öhman and Östman 2019).

The framework used in this article is adapted from the work of Öhman and Östman (2019) who, based on extensive empirical research, identify three selective teaching traditions in ESE: fact-based, normative, and pluralistic. The 'selective' in this context refers to a tradition that places an emphasis on specific aspects or approaches, while downplaying or excluding others (either consciously or unconsciously), and adopts certain perspectives, values, and methods that influence how sustainability is taught (Öhman and Östman 2019). These traditions influence what students learn, how they engage with sustainability issues, and how their role as a part of society and nature is portrayed. Each tradition has inherent challenges and are not necessarily choices made deliberately by the teacher, but rather selective teaching traditions that emerge in teaching situations (Sund and Gericke 2021; Öhman and Östman 2019). This article uses the specific characteristics of the three teaching traditions in ESE, that can be viewed in Table 1 to understand the possibilities and limitations of an artefact to be used in an educational context for ESE aims.

ESE, climate change and carbon emissions

A central aim of Environmental Sustainability Education (ESE) is to provide students with detailed, context-specific knowledge about sustainability, which is important for developing critical thinking, problem-solving skills, and factual understanding (Sund 2015; Sund and Gericke 2021). Within ESE, environmental challenges and ecological issues (such as climate change) are considered integral components that encompass

Table 1. Overview of the main characteristics within each of the three selective teaching traditions in ESE, adapted from Öhman and Östman (2019).

Traditions of ESE	Fact-based	Normative	Pluralistic
1.Perspective on sustainability problems	Sustainability problems are knowledge based and resolved by means of research and information.	Sustainability problems are moral and can be resolved by exerting an influence on people's attitudes and behaviour.	Sustainability problems are political and should be dealt with democratically.
2.Cause of sustainability problems	An unforeseen result of production and resource exploitation in society	A conflict between society and the laws of nature	Conflicts between humans' wide range of achievement goals
3.Main method of teaching	Factual information from teacher to student	Transferring sustainable values in student-active exercises	Critical discussions based on a number of alternatives
4.Purpose of ESE	Students receive knowledge about sustainability problems by learning scientific facts.	Students adopt sustainable attitudes and behaviour.	Students develop their ability to critically evaluate and take a standpoint on sustainability issues.
5.Aim of ESE	Citizens who have enough information to judge between different political alternatives in sustainability issues	Committed citizens who accept and approve of the changes needed in order to develop a sustainable society	Citizens who are competent to engage in the democratic debate and practices that concern a sustainable future
6.Fact-value focus (Emphasis on facts and/or values and relationship between them)	Facts	Facts lead to values.	Facts and values are interrelated.
7.The democratic process in relation to education	After	Before	In

complex dimensions such as emissions and inequalities at both structural and societal levels (Rudsberg and Öhman 2015; van Poeck et al. 2019; Öhman and Östman 2019).

Climate change refers to long-term changes in the earth's temperature and weather patterns. It is known that human activity is the main driver of climate change, mainly through the burning of fossil fuels such as coal, oil, and gas (Ripple et al. 2024). Climate change is strongly interconnected with short-lived reactive gases, greenhouse gases (such as carbon dioxide, $CO_{2,}$), which warm the atmosphere. Education about CO_2 and other emissions has been shown to be important for pro-environmental behaviour (Cordero, Centeno, and Todd 2020), providing a clear, quantifiable link between human activity and climate change (Howell 2018). Thus, teaching about CO_2 emissions should encompass scientific, economic, and ethical dimensions of sustainability, and address energy and climate injustices (Cordero, Centeno, and Todd 2020; Hays and Reinders 2020).

Howell (2018) found that when learning about emissions from production and consumption, peer learning situations helped students build skills and motivation for daily actions and community engagement to reduce emissions and cultivate sustainability. However, increased knowledge on climate change does not necessarily translate into changes in viewpoints or climate-friendly behaviour (Shi et al. 2016; van Valkengoed, Abrahamse, and Steg 2022). Authentic education, meaningful tasks connected to the real world context, is also important for engagement and learning (Murphy, Lunn, and Jones 2006). Games used to support learning or skill development are often classified as serious games and is recognised as effective tools in education (Mayer et al. 2014). In the context of serious games, authenticity plays an important role in whether students perceive the content as meaningful and relevant and in turn can enhance engagement and support the transfer of knowledge or skills to real world situations (Tsekleves, Cosmas, and Aggoun 2016).

Educational games as artefacts for learning

Artefacts are cognitive tools employed to aid learning (Säljö 2014) and in this study, games are categorised as artefacts. Games can promote active learning, engage students, inspire action and simplify sustainability issues due to their applicability in multiple age ranges, engaging nature and the provision of problem-solving challenges (McGonigal 2011; Ouariachi et al. 2019; Reckien and Eisenack 2013).

Educational research includes a substantial body of work regarding games (de Freitas 2018; Mayer et al. 2014) including those with a sustainability focus, both digital and analogue (Fernández Galeote and Hamari 2021; Gerber et al. 2021; Pineda-Martínez et al. 2023; Reckien and Eisenack 2013). Research has, for instance, classified games to examine the purpose and content to provide insights into the educational potential to enhance scientific knowledge and develop decision-making and communication skills (Gerber et al. 2021; Reckien and Eisenack 2013). Notably, Janakiraman, Watson, and Watson (2018) reviewed existing research to determine if digital games could serve as tools for ESE by influencing attitudes and fostering behavioural changes in young learners. Their findings indicate that games have the potential to engage learners emotionally and allow them to make significant decisions within a secure setting, which enhances learning and promotes the

development of lasting behaviours and facilitates collaborative learning among participants. The evidence from the studies and experiments analysed in the article suggests that games can be an effective educational tool for altering attitudes and behaviours related to environmental sustainability (Janakiraman, Watson, and Watson 2018).

However, while educational games may be a good resource for learning, Fernández Galeote and Hamari (2021) highlight a lack of features such as credibility, achievability, and social aspects in educational games with climate content for example. Hence, more research is needed on the implications of using educational artefacts like games in sustainability education.

The data for this article is derived from the game Climate Call, a card game about carbon emissions from authentic daily activities (see Figure 1) and its additional materials developed to fit Swedish secondary and upper secondary schools' curricula in several subjects with tasks based on the games content. The game was chosen partly because it was developed by climate scientists with accurate calculations and a solid scientific basis, and because it has been distributed widely to teachers throughout Sweden, Norway, Turkey and Estonia. It has also been translated into several different languages and adapted to other countries context. The layout is simple, and no prior knowledge is required to be able to play the game, yet it is relevant to ESE education due to its content. More information about the game and the additional material can be found on the game's webpage (https://climatecallgame.com).

In Figure 1 an example of a card in the *Climate call* game is presented. One side shows an everyday activity, and the other side shows the amount of CO_2 emitted because of this activity. The game is played in teams, where participants take turns to guess whether the activity on the next card shows higher or lower carbon emissions than the previous cards.

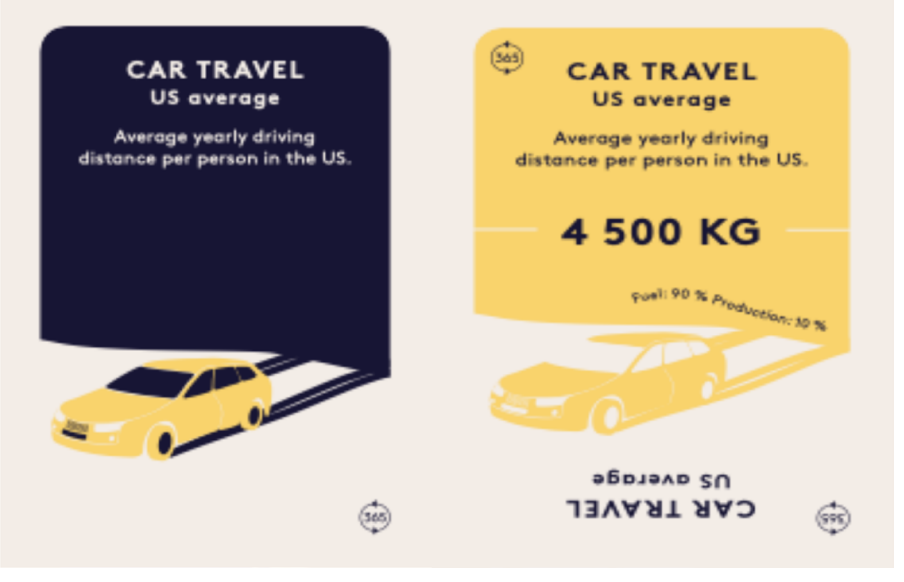

Figure 1. One of the cards of the deck of the game climate Call.

The role of artefacts in didactical situations

In continental Europe, didactics is understood as the professional science of teaching. It is encompassing not only instructional methods but also analytical tools for planning, delivering, and evaluating teaching and learning (Hopmann 2007). A central concept in this tradition is the didactical triangle (see Figure 2), which models the dynamic relationship between teachers, students, and content (Hopmann 2007; Ligozat and Almqvist 2018).

However, teaching does not occur in a vacuum. Educational resources and artefacts, such as textbooks, digital tools and games, significantly shape how content is accessed, and learning unfolds. Rezat and Sträßer (2012) propose extending the didactical triangle, into a didactical tetrahedron (see Figure 3) to better account for the influence of educational artefacts, making it a more comprehensive model. The didactical tetrahedron illustrates how artefacts like card games can actively shape both knowledge acquisition and the social dynamics of learning (Rezat and Sträßer 2012). While the didactical tetrahedron model has primarily been applied in mathematics education, Rezat and Sträßer (2012) argue for its broader applicability across subjects, there is a gap in more extensive research in these contexts. In this article, the card game

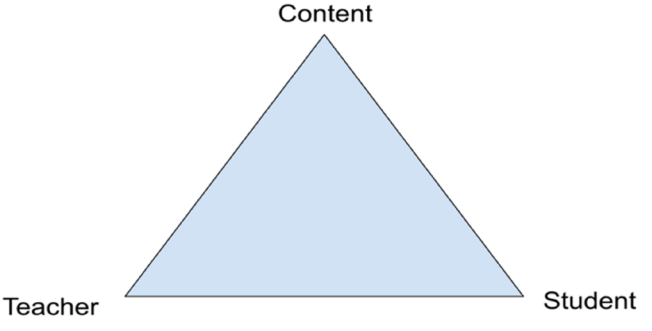

Figure 2. *The didactical triangle.* Figure adapted from Hopmann (2007, p.111).

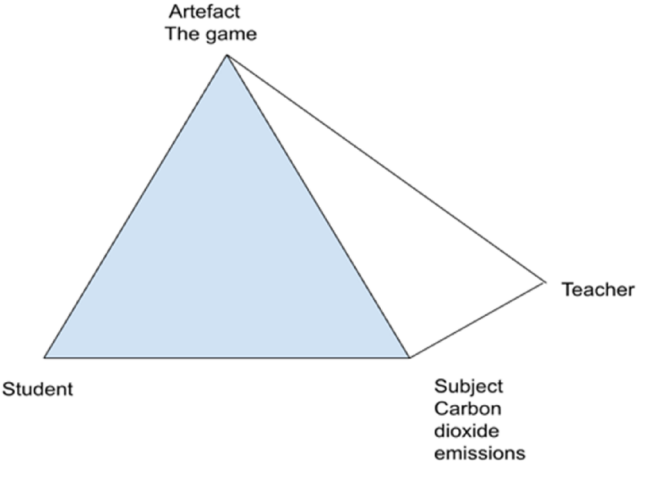

Figure 3. *The didactical tetrahedron.* Figure adapted from Rezat and Sträßer (2012, p.645).

serves as the artefact within the didactical tetrahedron model, interacting with content, teachers, and students to facilitate learning about CO_2 emissions and the broader context of climate change as part of ESE.

While digital games may offer various benefits in an educational environment, non-digital games, such as the card game Climate Call, provide opportunities for learning through direct social interaction, negotiation, and critical thinking within a structured environment. Social interactions are important for the learning process. Nyman (2017) emphasised that learning depends not only on where it occurs but also how it is facilitated and what artefacts are involved.

Examining Climate Call through the lens of the selective teaching traditions in ESE, allows a deeper understanding of how educational artefacts can support different types of learning outcomes, ranging from factual knowledge to the development of critical thinking. This perspective also encourages educators to reflect how games are used in an educational context and what competences they are designed to promote. The use of the didactical tetrahedron can increase understanding of how the interactions between the content, the teacher, the student, and the artefact may influence learning outcomes. To our knowledge, there has not been any research on analysing games as an artefact using the didactical tetrahedron within a framework based in ESE, making this study a novel contribution to the corpus of ESE research.

Method

The data analysed for this article comes from the game Climate Call and the associated educational material that was developed by the game designers and intended for use in upper secondary schools. Climate Call was selected for its interdisciplinary structure, aligning the educational climate game structure as defined by Gerber et al. (2021), and its broad use in Sweden and internationally. The associated educational material consisted of 10 items: classroom tasks (individual or group based), presentation content, a rule sheet and a guide for teachers. All were designed for upper secondary school and intended for classroom use. Only two referenced the Swedish curriculum goals or use in specific subject areas; the rest were presented as cross-disciplinary. All the items were downloaded from the game's website, stored in a shared file for consistency, and given abbreviation codes, CCL (climate call learning material) and a number after the order the material was downloaded. Table 2 provides an overview of the items.

Analysis

To promote a systematic and rigorous analysis, to ensure transparency (Greckhamer and Cilesiz 2014), and to minimise subjective interpretations, a framework was created, based on that of Öhman and Östman (2019) main characteristics for each of the three selective ESE traditions: fact-based, normative, and pluralistic. These characteristics, (which are presented in Table 1), were then listed in an Excel document an excerpt of which can be seen in Figure 4 and processed using discourse analysis.

Table 2. Overview of the data material, based on the game climate call with a brief description of content.

Code and translated title	Brief description of content and analysis
CCL 1 Is locally produced always the best?	In class task Pages:2 Content: Discussion where the students are to find examples to support the claim that locally grown is not always better to convince a friend with the card game used as information *Keywords: Discussions, support claim, convince friends, use cards (facts).*
CCL 2 Climate visionaries	In group Pages: 1 Content: Students is to visualise, discuss and reflect upon what the world would look like after a successful climate transition *Keywords: Reflection, discussion, students*
CCL 3 Keep track of the climate with the card game Climate -Call	Assignment In class Pages:1 Content: The students play the game in school After each session, they have a discussion together with the teacher regarding questions the session has raised and preassigned questions. (Afterwards follows CCL9 play at home analysed separately.) *Keywords: Involved, climate-issue.*
CCL 4 Slide show	Educational material In class Pages: 22 Content: Slide show for teachers and students introducing the game, climate change and carbon emissions with small tasks imbedded *Keywords: Knowledge, changed behaviour, reflections*
CCL 5 Teacher's guide	Educational material In class Pages: 2 Content: A teacher's guide to incorporating the game into lessons or using the educational material. The material is inspirational. *Keywords: Discuss,*
CCL 6 Rule sheet	Educational material Pages: 2 Content: Game rule sheet also containing fundamental information on carbon emissions, climate change and connection to human activity. Low prevalence of teaching-tradition content, slightly elevated pluralistic. *Keywords: Information, knowledge, discuss.*
CCL 7 Card calculations	In group or individual task + Educational material Pages: 2 with online references for further reading Content: The students get information about how the cards are calculated. Students can search for information on how the emissions where calculated while playing or afterwards. *Keywords: Information, data, use data*
CCL 8 Calculate your cards	In group or individual task Pages:12 Content: Students design and calculate their own cards based on a template online and the database with CO_2 emissions the card game is based on. *Keywords: Information, calculations, skills, templates*
CCL 9 Play Climate Call at home	In group task Pages:1 Content: The students are assigned to play the game at home with friends and family and reflect on the game situation. (Connected to CCL3 but analysed separately) *Keywords: Bring knowledge home, discuss and reflect,*
CCL 10 Card suggestions	In group or individual task Pages: 1 Content: Assignment for students to discuss and suggest cards they would like to have in the game and discuss what would be of importance for others to include in the deck. *Keywords: Importance, choose, reflect*

Note: Each item is labelled with an abbreviation (CCL 1–10), representing *Climate Call Learning-material* and its download order. The table includes translated titles (from Swedish), a brief description of content, keywords representing the analysis and prevalence of the three selective teaching traditions.

Discourse analysis examines meanings associated with sets of concepts, objects, and subject positions and involves looking at language among other things (Gee 2014; Hardy and Phillips 2004). In our analysis, each of the items in the material was considered a text. Using discourse analysis with a deductive approach (Boréus and Bergström 2018), three researchers with experience in ESE processed the texts individually to avoid influencing each other. Each researcher independently noted what appeared to be an occurrence in a text of a characteristic from a particular teaching tradition and marked this as one 'score' in the Excel file - an example of a part of this file can be seen in Figure 4. This was followed by a comparison and discussion of the outcomes of these analyses. For further insight into the analytical work, see the findings section.

Findings

In this section, the results from the analysis of the educational material associated with the card game *Climate Call* is presented. The analysis focuses on identifying how the materials align with the three selective teaching traditions in environmental sustainability education (ESE).

Items aligning with the fact- based tradition

Items with a high alignment with the fact-based tradition are: 'Is locally produced always the best' (CCL1), 'Card calculations' (CCL 7) and 'Calculate your cards' (CCL8). CCL8 is an example aligning with the fact-based tradition, where the students are given the task by the teacher, and asked to use a template and numbers from already existing cards to construct their own cards. When looking at the *main method of teaching* in CCL8, activities such as 'Let students practice their creativity and

Figure 4. Screenshot of the analysis 'calculate your cards' CCL8 in the fact-based teaching tradition.

Note: Categorisation of item CCL8 'Calculate your cards' in the fact-based teaching tradition: Excerpt from the Excel file used in the deductive discourse analysis. The example shows the item 'Calculate your cards' (CCL8) within the fact- based teaching tradition forming the study's analytical framework.

calculation skills by having them do their own calculations for the cards' are evident. The reference to 'calculation skills' aligns with the fact-based tradition. Another part of the text says: 'The students calculate an already existing card and then check their calculations with our calculations', which again, points towards fact-based knowledge. Looking at the task, which is about the amount of carbon dioxide that different activities emit, the *purpose of ESE* can be interpreted as being that the *students receive knowledge about sustainability problems by learning scientific facts*, aligning with the fact-based teaching tradition. Regarding the *perspective on sustainability problems,* this item aligned with the fact-based tradition, as the task aims to build students' knowledge and calculation skills in relation to carbon dioxide emissions from different activities implying that sustainability problems are knowledge-based and resolved by means of research and information.

Items aligning with the normative tradition

Items with a high alignment with the normative traditions are: 'Keep track of the climate with the card game Climate Call' (CCL3) and 'Slide show' (CCL4). In CCL3 the students are asked to play the game and discuss it with each other and the teacher and reflect on the placement and content of the cards when they are playing. Regarding the characteristic *perspective on sustainability problems,* the analysis suggests that this item implies normative views (*sustainability problems are moral and can be resolved by exerting an influence on people's attitudes and behaviour*) as the students are to discuss what went right and what went wrong and also argue why the placement should be where they place the card. The text also states that 'students get to know the game and the questions that arises' and 'discuss what went right or wrong and what was most surprising' implying that for something to be surprising they had another viewpoint before. In relation to the *purpose of ESE*, this can be interpreted as normative (*Students adopt sustainable attitudes and behaviour)*, and the *aim of ESE* here can also be interpreted as normative (*Committed citizens who accept and approve of the changes needed in order to develop a sustainable society*). However, the instructions of arguing for what they think is the right placement of the cards may also be interpreted as pluralistic (*Students develop their ability to critically evaluate and take a standpoint on sustainability issues*), as students are given the opportunity to discuss and reflect. In relation to the *main method of teaching*, this item indicates a normative view (*Transferring sustainable values in student-active exercises*), as the students play the game and then reflect on this in school. This fits with the overall tone of the task, as well as with the further instructions in 'Play Climate Call at home' (CCL 9), the task that follows. In that task the students are to come back and discuss their experience with the teacher after they have played at home with friends and family.

Items aligning with the pluralistic tradition

Items that align with the pluralistic tradition are: 'Climate visionaries' (CCL2), "Teacher's guide" (CCL5), "Rule sheet" (CCL 6) and "Card suggestions" (CCL 10). Play Climate Call at home (CCL 9) has also a high alignment with the pluralistic tradition. 'Climate visionaries' (CCL 2) is a student-centred item, that is a short text where the students are asked to imagine a future after a climate transition and have discussions in small

groups. The *main method of teaching* in this example is indicated by the text: 'Discuss in small groups and/or draw pictures of how the world might appear', suggesting a pluralistic view (*Critical discussions based a number of alternatives*). Regarding the *purpose of ESE*, a pluralistic view is also indicated here, as students are encouraged to think about and discuss a future world (*Students develop their ability to critically evaluate and adopt a position on sustainability issues*).

Items with diverse alignment

The findings reveal a diverse alignment with the teaching traditions in the analysed material. How much the materials align with the three selective teaching traditions in ESE, can be viewed in Figure 5 according to our deductive discourse analysis. When examining the analysed material following patterns emerge: 'Teacher's guide' (CCL 5), 'Rule sheet' (CCL6) and 'Card calculations' (CCL7) have a clear focus on conveying information only and thus has a lower alignment to any of the teaching traditions and contains a low degree student activating content. In items such as 'Slide show' (CCL4), 'Play Climate Call at home' (CCL 9) and 'Card suggestions' (CCL 10), the distribution of teaching traditions is similar, yet they contain different tasks with different formats. The similarities with these items are that they contain different aspects of student activity and different use of the games content. Although fact-based alignment is highest in 'Is locally produced always the best' (CCL1) and 'Calculate your cards' (CCL8) they were both tasks where the games cards and calculations as an information source is the content for either forming claims or using the underlying information. Both these items can be seen as possibly aligning with the other traditions as well.

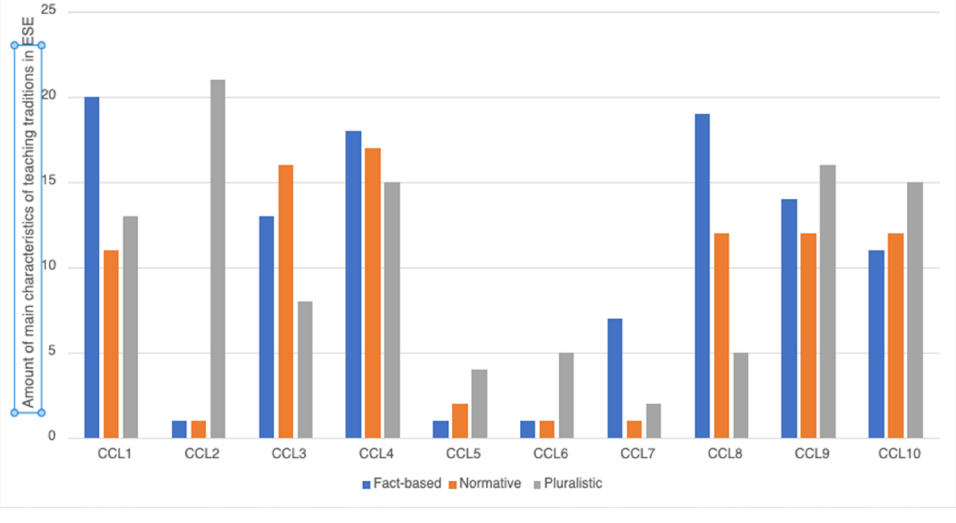

Figure 5. The distribution of teaching traditions according to the analysis of each item individually.
Note: CCL is short for *Climate Call* learning material and each column in one of the materials, so CCL 1 is the material 'Is locally produced always the best?' The y axel consists of columns of the occurrence of the teaching tradition characteristics in each material (CCL). The X- axel is the amount of occurrence of each tradition under each material. The blue columns are the occurrence of fact-based characteristics, the orange normative characteristics and grey pluralistic characteristics. For a full description of each material (CCL) see Table 2.

Normative alignment is highest in 'Keep track of the climate with the card game Climate Call' and 'Slide show' (CCL4) both having predesigned questions with a content that can be interpreted as promoting environmentally friendly behaviour. Pluralistic alignment is highest in 'Climate visionaries' (CCL2) and 'Play Climate Call at home' (CCL 9) while 'Card suggestions' (CCL10) has a mix of teaching traditions with a slightly higher alignment with the pluralistic tradition. The pluralistic tradition emerges in tasks where the students are active and get to discuss and reflect on broader issues without set questions or templates.

When we summarised the occurrence of alignment with each teaching traditions in the material analysed, the results were as follows; fact-based was identified 105 times, pluralistic 104, and normative 85 times. All the teaching traditions are represented in all 10 materials analysed and the fact-based tradition and the pluralistic tradition are equally prevalent. In contrast, the normative tradition is slightly less prevalent. A challenge in discourse analysis is warranting knowledge claims (Greckhamer and Cilesiz 2014) as discourse is an interpretation. These results therefore come with a disclaimer that the analysis and interpretations are our own, though we have tried to be systematic, rigorous, and transparent in showing our results to increase the trustworthiness of this study.

Discussion

This study examined how the card game *Climate Call*, and the associated teaching material, align with fact-based, normative, and pluralistic teaching traditions in ESE. The analysis shows that all selective teaching traditions are present throughout the material to a varying degree and with fact-based and pluralistic being the most prevalent and normative less prevalent. Materials with limited student activation, such as 'Teacher's guide' (CCL 5), 'Rule sheet' (CCL 6), and 'Card calculations' (CCL 7) may does not align as much with the teaching traditions. In contrast, materials encouraging discussion or reflection, like 'Climate visionaries' (CCL 2), 'Play Climate Call at home' (CCL 9), and 'Card suggestions' (CCL 10), show a stronger pluralistic orientation, while fact-based content dominates in tasks using game data, Is locally produced always the best? CCL 1) and 'Calculate your cards' (CCL 8). Normative elements appear most in materials with guided questions promoting pro-environmental behaviours, 'Keep track of the climate with the card game Climate Call' (CCL 3) and 'Slide show' (CCL 4).

These findings likely reflect broader trends in how games and educational material is designed and used in an educational context, which is often with an emphasis on what can be viewed as fact-based and pluralistic approaches. Also, the associated material is constructed with the game as a foundation and designed to be used in upper secondary school in a Swedish context. This aligns with the goals outlined in the Swedish curriculum, which emphasizes both factual knowledge and critical thinking, while encouraging teachers to facilitate and encourage critical thinking over specific attitudes. This imbalance does not necessarily weaken the materials' educational value but may suggest that normative potential depends on how a game and tasks are framed and used.

An important implication of this result suggests that the game *Climate Call*, while it has a strong fact-based core, can provide a broader pedagogical stance, depending

on how it is used by the educator. The alignment of all the teaching traditions in the material show that artefacts have a flexibility to be used in a versatile way like for a pluralistic approach giving the students possibilities to critically assess and test ideas, vital for handling sustainability issues (Rudsberg and Öhman 2015; Sund and Gericke 2021; Öhman and Östman 2019).

Viewed through the lens of the didactical tetrahedron, this flexibility positions the game as a mediating artifact that supports dynamic interactions between teachers, students, content and purpose where a single resource may serve diverse pedagogical purposes. This is something that Rezat and Sträßer (2012) discuss regarding the use of artefacts in a classroom context. As the artefact is multidimensional, it creates a bridge between teacher and subject, while also opening the way for discussions on broader topics like climate change and including facts, ethics, and socio-political content, and aligning with ESE objectives (van Poeck et al. 2019; Öhman and Östman 2019). However, this is less likely to happen without help or scaffolding, as the teacher can act as a provider of guidance and, depending on the artefact, be flexible in using different teaching approaches.

Understanding a game like *Climate Call* as an educational artefact emphasises the potential to support content learning, collaboration and critical thinking. However, this calls for high levels of an educator's awareness, particularly in an ESE context. As Rezat and Sträßer (2012) notes, an artefact can both enable and constrain educational possibilities. The game as an artefact may not encourage students to question underlying assumptions or power structures, which is often emphasised in critical ESE approaches. Neither will it bring in issues of ethics and socio-political content or even connect CO_2 emissions to climate change without the support of a teacher, as the cards only present calculations that are to be seen as facts. According to Sund and Gericke (2021), the mere presentation of factual knowledge, as in the fact-based tradition, is not sufficient to drive behavioural change, for example, so it cannot be assumed that individuals will undergo change just by playing a game and acquiring knowledge. Also, without scaffolding by a teacher, students may struggle to make meaningful connections between the game content and wider sustainability challenges as suggested by Fernández Galeote and Hamari (2021). As Murphy, Lunn, and Jones (2006) argues, students are more engaged when educational content is authentic, relevant and grounded in real-world context. This suggests that if a game lacks perceived authenticity students may struggle to find the content or gaming situation relevant or meaningful also suggested by Tsekleves, Cosmas, and Aggoun (2016).

It is difficult to provide specific pedagogical strategies for using the analytical insights from this article as practical advice for teachers. However, this study highlights games, as a valuable educational tool, to help shape both the pedagogical context and the boundaries of what is possible in a learning situation. Games as artefacts not only carry content but also influence how the content is framed and interpretated. As such, both educators and game developers need to be mindful of the kinds of outcomes and teaching tradition that a game may implicitly support. Designers of games used for educational purposes should consider supporting teachers with guidance, such as what purposes the game will or can serve, especially if the game is developed for educational use. This would help teachers to integrate games into a broader context and ensure that the game as an educational artefact complements the didactical situation. However,

there is always a risk of oversimplification of the content, potential biases in game design, and an imbalance between entertainment and education in a learning context

The game as an artefact creates a social setting in an educational context that can be beneficial, as social interactions are a key component of the learning process (Nyman 2017) and set frames for learning opportunities. In this way, the artefact shapes not only what is learned but also how learning takes place (Säljö 2014).

Limitations

This study focuses on a single educational artefact, *Climate call* with supplementary material, and applies a theoretical framework to analyse its alignment with ESE teaching traditions an intentionally narrow scope to allow for an in-depth analysis within the didactical tetrahedron. However, analysing only one game limits the generalisability of the findings to other educational artefacts or classroom contexts.

Future research

Further research will incorporate empirical data from a classroom context to validate the findings of the theoretical analysis. To examine how the game functions within the didactical tetrahedron framework with a focus on the student perspective instead and how the interplay between content, purpose, teacher, and artefact influences learning would also offer interesting and needed knowledge. Studying how teaching traditions emerge during gameplay in an educational context would add important depth to the current analysis. Further studies might also explore how other artefacts, particularly games with an ESE focus, can be analysed with the framework used.

Finally, exploring students' emotional engagement with the game, sense of authenticity and how the game facilitates discussion on a societal and cultural level, critical thinking and learning to further create an understanding the role of artefacts in ESE would offer valuable knowledge for both educators and game designers.

Conclusion

This study offers an analysis of the game *Climate call* and its supplementary materials through the lens of ESE teaching traditions and the didactical tetrahedron. The findings show a higher occurrence of items aligned with fact-based and pluralistic elements with a lesser presence of normative elements. The analysis suggests that the educational potential of the game lies not only in its content but also in how it is framed and facilitated by educators. When paired with well-designed materials it is an artefact that can provide a flexible foundation for supporting different ESE goals. However, this potential is dependent on the teachers or designers' ability to scaffold learning, relate content to broader sustainability issues, and engage students in critical discussions.

Thus, limited by its theoretical scope and focus on a single artefact, this study highlights how educational materials can be interpreted and used in a variety of ways to support ESE learning. Further empirical research is needed to explore how an artefact

like the game *Climate call* function in a classroom context, particularly student engagement and response. Understanding a game as an educational artefact contributes to a deeper awareness of how content, context and learning intersect in ESE education.

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I, the author declares having a professional acquaintance with one of the researchers who developed the game used in this study. However, I the author confirm having no financial interest, stake, or other incentives tied to the dissemination or success of the specific game. This relationship has not influenced the research process, analysis, or findings, ensuring the integrity and impartiality of the study.

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