Human Culture and Science Fiction: A Review of the Literature, 1980-2016

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Abstract

This article aimed to uncover the foci, themes, and findings of research literature that utilized science fiction content or concepts to describe and illustrate human culture. To capture a representative range of research, the PRISMA process was applied to database searches across a range of disciplines, not restricted to science fiction journals. Findings revealed that science fiction literature has been used in research across disciplines including theology, semantics, natural sciences, and education. Two characteristics of the use of science fiction in research became evident in the review: its role as a tool for advocacy and cultural insight and its effectiveness as an aid to learning and teaching. An unclear boundary between real science and science in the public imagination is problematic for research success, but the purposeful integration of fictional representations of science (both natural and social) into the research story has demonstrable benefits. To address the limited application of objective methodologies, adoption of increasingly robust quantitative analysis into research in the fields of literature and culture is recommended. This would assist in bridging the two cultures divide between the humanities and natural sciences.

Keywords

Introduction

Culture has been defined as "the symbolic, ideational, and intangible aspects of human societies. The essence of a culture is not its artifacts, tools, or other tangible cultural elements but how the members of the group interpret, use, and perceive them" (Banks & Banks, 2004, p. 8), or, more simply, as knowledge and behaviors shared within groups of interacting individuals (Useem, Useem, & Donoghue, 1963). For the purposes of this review, we accepted that the search terms employed would capture the definitions of culture that were understood by the authors of the sources we discovered. These sources indicated that science fiction has become prominent in social and cultural research that is not purely focused on science fiction content, but which uses science fiction to complement research across a broad range of disciplines and research activities.

Science fiction is significant in studies of human culture as it is an ancient and enduring form of literature that has been part of what Brian Aldiss called our "cultural wallpaper" since the origins of recorded history (Aldiss & Wigmore, 1986, p. 14). Adam Roberts suggested that science fiction begins with the "voyages extraordinaires" of the Ancient Greeks (Roberts, 2005, p. vii), but we might go back a millennium further to the Sumerian creation story, with the supreme god Marduk "cloning" mankind from the blood and bone of the renegade god Kingu (Enûma Eliš, 5.26). Science fiction became an increasingly significant genre for literary study after Darko Suvin's (1979) epochal publication of *Metamorphoses of Science Fiction*, which raised the profile of science fiction as a legitimate field of academic enquiry (Hassler, 1999). Suvin's work has become a core text around which the study of science fiction circulates, and it has been used accordingly as the limiting date for this review.

The complexities of the relationship between science fiction and human realities are manifest. From a literary-critical perspective, Carl Freedman described science fiction as the most legitimate genre for academic study, placing it above all other forms of literature for its analytical potential (Freedman, 2000). From the human perspective, science fiction has grown from a more or less plausible science focus in the early 20th century to adopt more sociological and cultural factors over time. By the 1960s and 1970s, science fiction generated by the "British New Wave" reflected dramatic changes in contemporary culture, especially political aspects of gender, conflict, and freedom of expression. Driven by the need to provide some sort of manageable interpretation of an

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increasingly complex and unstable social and intellectual reality, it absorbed and softened the impact of that complexity by depicting possible futures as being similarly iconoclastic and haphazard (Greenland, 1983). It has even been argued that the intermingling of science fiction and fact regarding the creation of artificial intelligences and synthetic humans permeates our culture so deeply that it influences our existential relationship with God (Geraci, 2007).

Science fiction questions the role, relevance, costs, and benefits of current and future technologies, and presents ideas that can influence public opinion. Brian Stableford claimed that science fiction could determine the worldview of individuals, by the modification of attitudes to the significance of current and future science and technology (Stableford, 1979). Marshall Tymn agreed that as a literature, science fiction equips us to accept change as natural and inevitable (Tymn, 1985). As change is a natural outcome of applied scientific research, science fiction has been employed as a tool by researchers to provide metaphors, analogies, and models that describe the findings of their research (Bina, Mateus, Pereira, & Caffa, 2017; Hansen, 2004; Kotasek, 2015; McIntire, 1982; Toscano, 2011). Human acceptance of change is difficult and resists authoritative statements of fact, as has been identified in applied psychological and sociological studies (Nyhan, Reifler, Richey, & Freed, 2014; Prochaska, DiClemente, & Norcross, 1992). Science fiction is an effective agent for change, and, as Stableford (1979) has suggested, it also has a "directive effect" on people's interpretations of science. Ann Rigney described how Kurt Vonnegut's widely read 1969 science fiction novel *Slaughter-House Five* has educated readers about the scale and impact of the bombing of Dresden, despite the dubious accuracy of Vonnegut's depiction compared with historical records (Rigney, 2009). This is an example of how science fiction can overwrite the cultural memory of historic events and has become "centrally relevant in many explorations of contemporary culture" (Hollinger, 1999, p. 1).

This "cultural wallpaper" exerts influence on society, which is persistent, and pervades the work of researchers in both the humanities and the natural sciences. Sheila Schwartz suggested that science fiction "is not *only* a bridge between the *two* cultures of science and the humanities; it is a bridge between all cultures as it summarizes and expresses the nightmare fears, myths, and inescapable concerns of all people today" (Schwartz, 1971, p. 1044). Science fiction narratives also provide a historical record of changes over time in social and cultural values that can be used to map these to their original contexts (Menadue, 2017). A deeper understanding of the relationship between research, culture, and science fiction is necessary, and the application of science fiction as a tool in the context of research should be encouraged. There is evidently a relationship between science, science fiction, and the cultural imagination, and the significance of this relationship should be assessed; however, reviews of academic literature on this subject were not located.

The purpose of this literature review was to provide an overview of the research relating science fiction to culture across a range of academic disciplines, and was not limited to science fiction studies. This review aimed to uncover the breadth and depth of the relationships between science fiction and human culture that have been expressed in peer-reviewed research that

1. investigated the uses of science fiction by researchers who described possible causal or correlational relationships between science fiction content, culture, and society; and/or
2. employed science fiction concepts as analogies to explain or illustrate cultural activity.

Selected journal articles and book chapters indexed in four online databases were analyzed. A limitation of the study was that nonindexed publications were excluded, and consequently, older and more specialized publications were underrepresented. The objectives of the review were to report the focus of research, theme of research, and summary findings. To add objective rigor to the study, the reviewing team included members from multidisciplinary backgrounds.

Method

A PRISMA[1] process was applied to identify papers and book chapters from JSTOR, PubMed, SCOPUS, and Web of Science databases. To ensure all relevant research literature was identified, an advanced search strategy was undertaken with librarian consultation, described in Figure. 1. We included articles and book chapters published in English. Reviews, editorials, and conference papers were excluded.

The scope of sources to investigate was based on publications between 1980 (following Suvin's Metamorphoses) and 2016. Web of Science Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI), SCOPUS, and PubMed databases were searched using the following search terms:

- Web of Science SSCI and A&HCI: Title Search = litera* AND (science AND ficti* AND cultur*)
- SCOPUS: Title Search, Abstract, Key Words = science AND Key Words ficti* AND Key Words = litera* AND Title, Abstract, Key Words = cultur*
- PubMed: ((litera*) AND science) AND ficti*) AND cultur*
- JSTOR: (((abstract:(science) AND abstract:(cultur*)) AND abstract:(litera*)) AND abstract:(ficti*))

Abstracts of retrieved publications were scanned for content that included overt or strongly implied themes related to science fiction and culture. Abstracts with no clear links between science fiction and cultural topics or with only peripheral references to science fiction and culture were excluded.
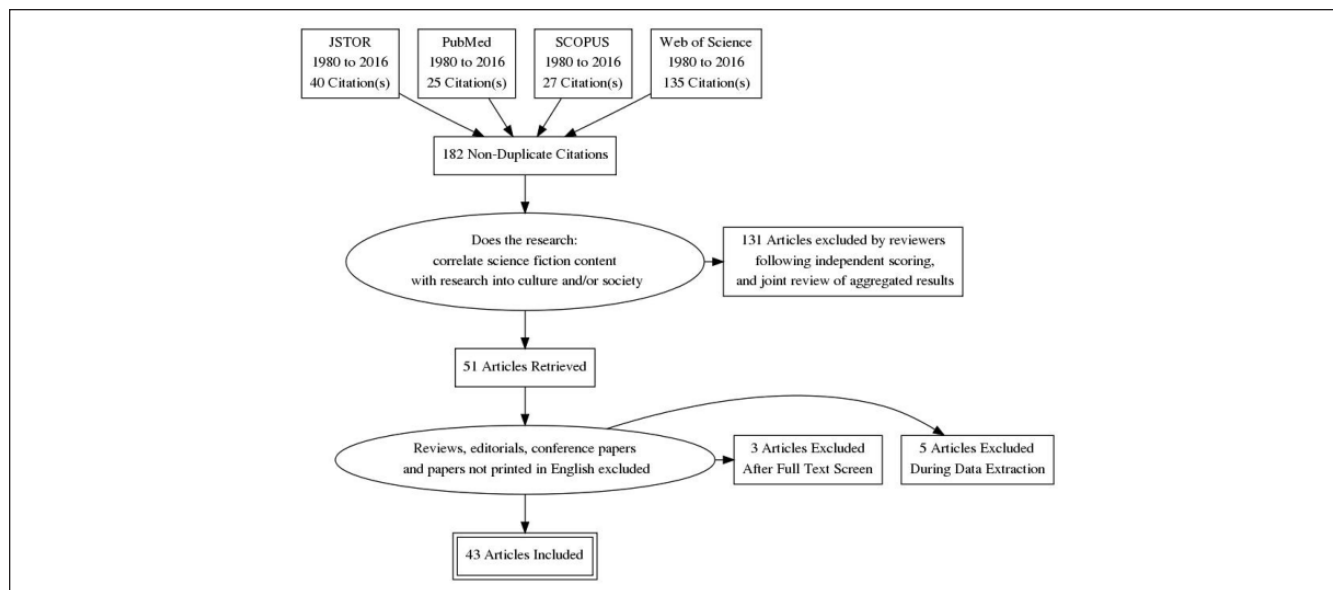
Figure 1. Flowchart of the selection of relevant articles using the PRISMA model.

Selected abstracts were distributed among the coauthors and an independent reviewer for validation according to three selection criteria:

Did the publication

- relate science fiction (SF) content or concepts to society or culture,
- employ science fiction to illustrate culture or society, or
- employ science fiction to illustrate, promote or otherwise advance science?

For each criterion, reviewers individually assigned a value from zero to three to each paper by examining the title and abstract content only. Total scores were aggregated. Papers receiving a score of six or more points out of the nine available across all categories, or three points in any one category were selected for full reading, which examined the research focus, research themes, data sources, methodology, and research findings.

Themes were classified into major headings using an iterative methodology of reduction from initially broad and descriptive themes to a list of summary themes.

Results and Discussion

The use of controlled vocabulary thesauri or subject headings varies across databases. For example, SCOPUS, as an indexing database, may include subject headings originating from a source database. Often however, documents from the humanities and social science fields in SCOPUS contain only author keywords. Authors choose keywords representing what they regard as the most significant descriptors of the content of their work (Névéol, Dogan, & Lu, 2010). This may result in duplication, as keywords are commonly terms appearing in the abstract (Mack, 2012; Strader, 2011). Furthermore, limitations on the number of keywords an author can nominate during the manuscript submission process, and whether these keywords/phrases are determined from a controlled vocabulary or using natural language influences keyword selection (Peh & Ng, 2008). Author selection of keywords affects retrieval patterns, indicating authors should carefully consider their target reading audience when self-selecting keywords.

Considering these factors, we searched across the selected databases using a combination of terms for title, abstract, and keywords. Our decision to restrict search parameters enabled more focused retrievals; however, a limitation of this method is that some papers published in journals with a science fiction focus may not have been retrieved. Performing full-text searching results in a greater number of retrieved documents but this can be at the expense of relevance (Beall, 2008). Researchers should, therefore, carefully consider search structure, working within individual database features to create an efficient search strategy that helps achieve their research objectives.

The study characteristics from each reviewed article are summarized in Table 1. The data from the selected articles come from 34 journals across 15 disciplines, and include results published in English of analysis of primary sources from eight countries, including material from Brazil, Russia, and Holland. Only four papers were published before 2000: two in the 1990s and two in the 1980s (Jameson, 1987; McIntire, 1982; Nerlich, Clarke, & Dingwall, 1999; Van Dijck, 1999). The prevalence of more recent works was due to the search methodology, which excluded hand searching, investigating works cited in the selected papers, or gray literature, rather than a reflection on the proportional volume of publications in this field over the period.

Table 1. Study Characteristics of Each Reviewed Article.

Author(s)	Date	Title		Publication	
Bainbridge, W.S.	2004	"The Evolution of Semantic Systems"		*Annals of the New York Academy of Sciences*	
Focus of research		Theme	Methods	Summary	
If scientific and cultural development can be assessed in terms of semantic and systematic systems, considering growing technological capabilities for computational analysis		Science and technology studies	Quantitative	The convergence of social and natural sciences brought about through technological applications and concerns may enable the collecting together of disparate disciplines with different approaches into a more functional and effective way of approaching the world from a convergent scientific perspective	
		Data sources			
		A range of critical–historical texts and quantitative analysis of online recommendation systems, surveys, and government statistics			
Author(s)	**Date**	**Title**		**Publication**	
Banerjee, A.	2003	"Electricity: Science Fiction and Modernity in Early Twentieth-Century Russia"		Science Fiction Studies	
Focus of research		Theme	Methods	Summary	
The depiction of electricity in 20th-century Russia and how it reflects political and cultural values and change		Connections between science fiction and human culture	Qualitative	Seemingly radical elements of the Bolshevik vision, such as the construction of a technological utopia in a traditionally "backward" agrarian society, originated and developed in the era that it actively tried to negate"	
		Data sources			
		Science fiction and historical texts			
Author(s)	**Date**	**Title**		**Publication**	
Bina et al.,	2017	"The Future Imagined: Exploring Fiction as a Means of Reflecting on Today's Grand Societal Challenges and Tomorrow's Options"		Futures	
Focus of research		Theme	Methods	Summary	
On the use of science fiction to identify trends in human interest and concern that can be used to inform the development of government policies on science innovation		Influence of human culture on science fiction content	Quantitative	Changes in public concerns and attitudes toward science and innovation should be monitored through examination of science fiction film and text, and governments and funding bodies should use this information to guide policy development	
		Data sources			
		Science fiction texts, government policy, and advisory papers			
Author(s)	**Date**	**Title**		**Publication**	
Brandau, D.	2012	"Cultivating the Cosmos: Spaceflight Thought in Imperial Germany"		*History and Technology*	
Focus of research		Theme	Methods	Summary	
How the boundaries between fiction and popular science became blurred in the 1900s: how this can be illustrated by the emergence of spaceflight as a popular fictional theme		Science and technology studies/two cultures	Qualitative	The links between science and fiction were of variable value in Imperial Germany but the relationship did demonstrate more general interests in science	
		Data sources			
		Primary texts and subsequent literary criticism			
Author(s)	**Date**	**Title**		**Publication**	
Carpenter, C.	2016	"Rethinking the Political/-Science-/Fiction Nexus: Global Policy Making and the Campaign to Stop Killer Robots"		*Perspectives on Politics*	
Focus of research		Theme	Methods	Summary	
The influence of science fiction on global international relations policy—carrying out objective observational research on this topic		Science communication	Mixed	More reliable information is gained by primary interview and participant observation than other interpretative or pedagogical approaches. Science fiction breeds familiarity but is not demonstrably causal of attitudes. This methodology exposes scope for further valuable work.	
		Data sources			
		Interviews, participant observation notes			
Author(s)	**Date**	**Title**		**Publication**	
Coyer, M.J.	2014	"Phrenological Controversy and the Medical Imagination: A Modern Pythagorean in Blackwood's Edinburgh Magazine"		Scottish Medicine and Literary Culture, 1726-1832	
Focus of research		Theme	Methods	Summary	
Studying the relationship between comparative representations of medical and fictional medical content in a single magazine and the resulting hermeneutic issues		Relationship between science fiction and science culture	Qualitative	Popular science and real science reinforce and inform each other. Writers and public seemed quite sceptical of phrenology (among other medical approaches that were covered in the magazine).	
		Data sources			
		Articles from Blackwood's Edinburgh Magazine			

Table 1. (continued)

Author(s)	Date	Title	Focus of research	Theme	Methods	Data sources	Publication	Summary
Dunnett, O.	2012	"Patrick Moore, Arthur C. Clarke and "British Outer Space" in the Mid 20th Century"	How the notion of "space from Earth" is illustrated by the works of Patrick Moore and Arthur C. Clarke and is linked to the philosophy of the British Interplanetary Society (BIS)	Relationship between science fiction and science culture	Qualitative	History of the BIS, BIS publications, works of Clarke and Moore	*Cultural Geographies*	This article seeks to rediscover trends such as the cosmographical connection to geography, working toward "a human geography of celestial space, a cosmography for the twenty-first century."
Erren, T.C.; Falaturi P.	2009	"Research Insights and Insides: "Science-in-Fiction" as a Contribution to the Third Culture Concepts"	How science fiction may be an instructional/educational medium addressing Snow's two-culture issues (synthesis of humanities and science) of 1960 and extension into a "third culture" by Brockman in 1995	Pedagogy/two cultures	Qualitative	Historic texts and history of popularization of science fiction	*Medical Hypotheses*	Science fiction can be used as an educational medium to promote science in two-culture and three-culture environments
Fendt, J.	2015	"The Chromosome as Concept and Metaphor in Amitav Ghosh's *The Calcutta Chromosome*"	To explore within the context of science studies how a subject of scientific research can be inscribed in a literary text and can offer insights beyond its "factual" or "hard" knowledge of the sciences	Science and technology studies/two cultures	Qualitative	Novel by Amitav Ghosh, history and philosophy of science, critical and analytical texts	Anglia-Zeitschrift Fur Englische Philologie	That fiction may be a good way of linking the imagination and the concrete and that this is essential for the proper development of science, that it forms an essential part of the cultural ecology that enables science to progress and there is a strong interconnectedness between science and literature
Geraci, R.M.	2007	"Robots and the Sacred in Science and Science Fiction: Theological Implications of Artificial, Intelligence"	Whether human beings have elevated intelligent machines to divine status and if this is a threat to traditional Christian theologies	Connections between science fiction and human culture	Qualitative	Primary fictional sources in literature, film and drama, theological literature, and criticism	*Zygon*	The allure and dread of technology often parallels human metaphysical and theological concerns and concepts. That our relationship with machine intelligence is ambivalent seeing it as both a source of fear and one of inspiration.
Ginway, M.E.	2005	"A Working Model for Analyzing Third World Science Fiction: The Case of Brazil"	Aims to create a critical model for analyzing third-world science fiction	Literary criticism/influence of human culture on science fiction content	Qualitative	Brazilian science fiction texts	Science Fiction Studies	Brazilian ideas of national and cultural identity are strongly demonstrated by the representation in science fiction of analogues for slaves and neoliberal colonists and the application of mythological Brazilian notions of their culture and values to overcome and surmount problems that appear in the narrative
Guerra, S.	2009	"Colonizing Bodies: Corporate Power and Biotechnology in Young Adult Science Fiction?"	Cultural concerns about technology that are reflected in the content of science fiction	Relationship between science fiction and science culture	Mixed	Science fiction texts aimed at juvenile readers, statistics, government committee reports, and marketing sources	Children's Literature in Education	Juvenile fiction concerned with cultural developments and impacts of the applications of biotechnology warn that the future of humanity will be defined by corporate greed and loss of individual freedom, and that the prevalence of these themes in fiction should be of concern to current policy and decision makers

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Table 1. (continued)

Author(s)	Date	Title	Methods	Data sources	Theme	Focus of research	Publication	Summary
Hansen, B.	2004	"Medical History for the Masses: How American Comic Books Celebrated Heroes of Medicine in the 1940s"	Mixed	Historical sources and contemporary comic book, film, and radio examples	Pedagogy/science communication	How comic book "real story" literature with medical heroes affected the perception of medical science and the attractiveness of a medical career to young Americans in the mid-20th century	*Bulletin of the History of Medicine*	It is very likely that the "true story" medical comics had a significant positive impact on the cultural value and profile of medical advances and medical scientists. That they provided simple but realistic information in an immediately accessible form and reflected the common themes in mass culture of the time.
Hills, M.	2003	"Counterfictions in the Work of Kim Newman: Rewriting Gothic SF as "Alternate-Story Stories""	Qualitative	Works of Kim Newman, other historical literary texts	Literary criticism	The distinction between the style and purpose of counterfictional, counterfactual, and fictional literature	*Science Fiction Studies*	The cultural politics of existent fiction can be explicitly and directly questioned by counterfiction. When existent fictional worlds become the starting point for extrapolation, a wider, more intertextual, view of science fictional "alternate-story stories" is called for.
Hrotic, S.	2014	"The Evolution and Extinction of Science Fiction"	Qualitative	Various secondary literature and critical commentary	Connections between science fiction and human culture	Cognitive group membership of SF genres, possibility that genre SF no longer exists as a specific—Steampunk as evidence to support this hypothesis	Public Understanding of Science	Familiarity with the disappointing outcomes of technological progress has led to a decline in the attractiveness of genre science fiction and this is reflected in a switch to an imaginative genre (Steampunk). This is rooted in an alternate reality that is able to conceive of a positivistic vision of technology and the future, borrowing this view from characteristics of Victorian culture.
Hull, E.A.	2005	"Science Fiction as a Manifestation of Culture in America"	Qualitative	*The Gods Themselves* by Isaac Asimov, literary criticism	Connections between science fiction and human culture/two cultures	The relationship between science fiction and broader American culture. The role of popular fiction as accessible cultural commentary	*Foreign Literature Studies*	Science fiction analysis is best carried out in a mixture of forms, that historical perspective is necessary for most interpretation, that science fiction contains rich examples and can be read from a number of different, mixed, perspectives.
Idema, T.	2015	"Toward a Minor Science Fiction: Literature, Science, and the Shock of the Biophysical"	Qualitative	Greg Bear's books: *Blood Music* and *Darwin's Radio*	Connections between science fiction and human culture/science and technology studies	Applying science and technology studies approaches (primarily) to the study of science fiction as a "minor literature," which is embedded in scientific and sociocultural constructs	Configurations	Science fiction, as well as other literature, can be read as a mode of thinking with science about the future of human life
Jameson, F.	1987	"Science Fiction as a Spatial Genre: Generic Discontinuities and the Problem of Figuration in Vonda McIntyre's 'The Exile Waiting'"	Qualitative	Vonda McIntyre's *The Exile in Waiting*	Literary criticism/connections between science fiction and human culture	What science fiction offers which goes beyond the formulas of soap opera and distinguishes it from what might be considered equally banal forms	*Science Fiction Studies*	Science fiction adds richness primarily due to the imaginary of space, being less to do with time than with more openly structured and flexible environments

Table 1. (continued)

Author(s)	Date	Title	Focus of research	Theme	Data sources	Methods	Publication	Summary
Jonsson, E.	2013	"The Human Species and the Good Gripping Dreams of H.G. Wells"	How early stories by Wells reflect upon evolutionary and cultural historical/biographical factors that give them their resonance and lasting success	Relationship between science fiction and science culture/ connections between science fiction and human culture	Early works by H.G. Wells: The Time Machine and The Island of Dr. Moreau	Qualitative	Style	Wells explored the differences between natural and artificial culture that were new and confronting during his period, the theory of evolution only recently having been published. That adventurous "gripping yarns" on these topics have become Wells' legacy due to their popularist content.
Kohlmann, B.	2014	"What Is It like To Be a Rat? Early Cold War Glimpses of the Post-Human"	Ecology: Exploring the interaction and mutual reinforcement of cultural concerns in early cold-war literature and science	Relationship between science fiction and science culture/ connections between science fiction and human culture	Four primary texts and the history of contemporary scientific and cultural views on ecology	Qualitative	Textual Practice	Early cold-war fascination with the posthuman drove a preoccupation with nonhuman forms of human existence and consequently raised ecological concerns for the future
Kotasek, M.	2015	"Artificial Intelligence in Science Fiction as a Model of the Posthuman Situation of Mankind"	The function of science fiction in shaping ideas about evolution, posthumanism, artificial intelligence, and the processes that define the human mind	Connections between science fiction and human culture/ connections between science and technology studies	Primary fictional texts and secondary critical literature	Qualitative	World Literature Studies	Connections between humans and technology, and fiction written about technology, exist in a hermeneutic relationship
Larsen, K.	2011	"Hobbits, Hogwarts, and the Heavens: The Use of Fantasy Literature and Film in Astronomy Outreach and Education"	Use of fantasy literature to teach astronomy	Pedagogy	Fantasy literature primary texts and curricula content designed for astronomy education	Qualitative	Role of Astronomy in Society and Culture	That fantasy literature is a very effective tool for teaching astronomical science
Lin, T.H.	2013	"Beyond Science Fiction: Vladimir Odoevskij's The Year of 4338 as a Hybrid Text"	Classification of a specific work of science fiction as a genre hybrid	Literary criticism	Primary text	Qualitative	Russian Literature	That the work in question is more effectively considered as a hybrid text than specific genre
Maguire, M.	2013	"Aleksei N. Tolstoi and the Enigmatic Engineer: A Case of Vicarious Revisionism"	Analysis of the relationship between science fiction featuring engineers and their status in contemporary society esp. Stalinism	Science and technology studies	Primary texts	Qualitative	Slavic Review	There is a strong correlation between the socio/cultural environment of Stalin's Russia and how harshly or positively engineers were portrayed in fiction

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Table 1. (continued)

Author(s)	Date	Title		Publication
McIntire, E.G.	1982	"Exploring Alternate Worlds"		Yearbook—Association of Pacific Coast Geographers
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
To examine how geographers might benefit from examining how science fiction treats notions of space and environment		Pedagogy/science communication	Science fiction texts and geographical literature	Qualitative	Science fiction provides a way of creating environments and ecologies and modeling human interactions with them that enables us to see our own geographical and environmental issues in a fresh light

Author(s)	Date	Title		Publication
Miller, T.S.	2011	"Preternatural Narration and the Lens of Genre Fiction in Junot Diaz's The Brief Wondrous Life of Oscar Wao"		Science Fiction Studies
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
Examination of the role of science fiction as a lens through which to focus the narrative of the novel *The Brief Wondrous Life of Oscar Wao*		Literary criticism/two cultures	*The Brief Wondrous Life of Oscar Wao* by Junot Diaz, genre and secondary literature	Qualitative	Science fiction serves as a very effective lens through which the narrative of the novel is focused, in part due to the expansive and imaginary qualities of the genre

Author(s)	Date	Title		Publication
Milner, A.	2009	"Changing the Climate: The Politics of Dystopia"		*Continuum-Journal of Media & Cultural Studies*
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
To test theoretical models of utopia/dystopia in science fiction studies and assess the value of science fiction as the source of thought experiments on climate change		Pedagogy	*The Sea and Summer* by George Turner (1987), SF literary criticism and theory, historic literary dystopia novels	Qualitative	There are undervalued yet apposite tales of resonance and wonder, intelligence, and warning to be found in Australian dystopian SF. That these stories have resonance with the environmental questions and issues raised in contemporary society

Author(s)	Date	Title		Publication
Nerlich, B; Clarke, D. D.; Dingwall, R.	1999	"The Influence of Popular Cultural Imagery on Public Attitudes Towards Cloning"		*Sociological Research Online*
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
How existing human ideas about science, often expressed in metaphors and sourced from science fiction, influence public perception of and representations of science		Science communication	Literature and media reporting on cloning	Qualitative	Discourse on cloning is based on a network of metaphors and commonplaces that are provided by vivid images linked to science fiction media. We use common knowledge to provide meaning and cannot ignore the impact of public images of technology that have been created in fiction.

Author(s)	Date	Title		Publication
Newell, D; Lamont, V.	2005	"Rugged Domesticity: Frontier Mythology in Post-Armageddon Science Fiction by Women"		*Science Fiction Studies*
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
How women represented domesticity and frontier themes in SF written by women pre-1970		Literary criticism/influence of human culture on science fiction content	Four primary SF texts by women	Qualitative	Female SF writers made strong contributions to feminist literary concepts before the 1970s, that they portrayed a characteristic "frontier" domestic style in the representation of women in the narrative

Author(s)	Date	Title		Publication
Parrinder, P.	2009	"Robots, Clones and Clockwork Men: The Post-Human Perplex in Early Twentieth-Century Literature and Science"		*Interdisciplinary Science Reviews*
Focus of research		**Theme**	**Data sources**	**Methods**	**Summary**
The distinction between the human and posthuman as portrayed in science fiction and from a historical perspective on the nature of humanity		Connections between science fiction and human culture	Historical cultural concepts of the posthuman, both literary and scientific	Qualitative	Consideration of the gradually changing historical concepts of what it is to be human informs the current (and complex) posthumanism debate and contrasts the postmodern approach to earlier perspectives. A historical view is invaluable for rationally examining current debates.

Table 1. (continued)

Author(s)	Date	Title	Focus of research	Theme	Data sources	Methods	Publication	Summary
Piper, A.	2013	"Leo Perutz and the Mystery of St Peter's Snow"	Analyzing the validity of belief that a specific work of science fiction was prophetic	Literary criticism	Primary source and comparative historical literature	Qualitative	*Time & Mind—The Journal of Archaeology Consciousness and Culture*	That the author would have had ready access to preexisting information that would explain the narrative content without the need for prophecy
Rabkin, E.S.	2004	"Science Fiction and the Future of Criticism"	The future of criticism lies in making qualitatively more informed, imaginative, judgments that draw on systemic analysis of a vast, technologically mediated set of collective knowledge and experience	Literary criticism/connections between science fiction and human culture	Examples of cultural artifacts in science fictional culture. Analysis of 1,959 stories in American SF Magazines between 1926 and 2000	Mixed	Publications of the Modern Language Association	Science fiction is a "system" that reflects modes of modern science, and is fundamentally networked and collaborative. It is the most influential cultural system now that technological change "constantly provokes hope, fear, guilt, and glory." Analysis of science fiction texts may provide insights into cultural attitudes and contemporary society.
Rutten, K; Soetaert, R; Vandermeersche, G.	2011	"Science Fiction and a Rhetorical Analysis of the 'Literature Myth'"	What science fiction tells us about cultural literacy and literary culture, analyzed through work of rhetorician Kenneth Burke. Examining specifically science fiction as "equipment for living" (literature) as a genre of "satire by entelechy."	Literary criticism	Works of Kenneth Burke, selection of primary fiction texts—1984, *Brave New World*, *Fahrenheit 451*, TV and Film	Qualitative	CLCWeb: Comparative Literature and Culture	Rhetorical analysis of science fiction narratives "offers possibilities to reflect critically on our contemporary attitude towards literacy, literacy culture, and art in general . . . perspectives of the future dramatized in science fiction reveal much about the context in which these narratives are told and therefore can teach us something about cultural practices and social values."
Schwartz, M.	2013	"How Nauchnaia Fantastika Was Made: The Debates About the Genre of Science Fiction From NEP to High Stalinism"	Genre definition and role of Soviet Science Fantasy. Relation between cultural demands and literary content and form—especially anxieties and stress	Science and technology studies	Literature, contemporary accounts	Qualitative	*Slavic Review*	The efforts of the Soviet state to control science fantasy were inconsistent and had strong influences on direction at certain times, even subduing the genre almost entirely during the mid-1950s.
Shaddox, K.	2013	"Generic Considerations in Ishiguro's 'Never Let Me Go'"	How sentiment and the rights of the human are expressed in *Never Let Me Go* similarly to abolitionist literature, and other emotionally charged cultural critique	Literary criticism/connections between science fiction and human culture	Primary texts and subsequent literary criticism	Qualitative	*Human Rights Quarterly*	That *Never Let Me Go* has stronger links to sentimental literature than to science fiction and that the issue it discusses deserves broader treatment outside of fantastical fiction
Sielke, S.	2015	"Science Studies and Literature"	The link between science studies and the cultural work of literary texts that probe the history of knowledge production	Science and technology studies	Science studies research, historical two and more cultures debates and the work of Richard Powers	Qualitative	Anglia-Zeitschrift Fur Englische Philologie	Defines and positions science studies within the current discussions on science, culture, and literature

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Table 1. (continued)

Author(s)	Date	Title	Methods	Publication
Slaughter, A.	2014	"Ray Guns and Radium: Radiation in the Public Imagination as Reflected in Early American Science Fiction"	Qualitative	Science & Education
Focus of research The representation of radiation in early American science fiction as a corollary to existing history and philosophy of science treatments of the subject		**Theme** Science and technology studies	**Data sources** Amazing Stories, 1929 and Astounding Science Fiction, 1934	**Summary** Early science fiction reflects the popular interest in science but does not contain proper or realistic scientific method.
Steinmuller, K.	2003	"The Uses and Abuses of Science Fiction"	Qualitative	Interdisciplinary Science Reviews
Focus of research Influence of science fiction on science, pseudoscience, and the realism of science and scientists portrayed in literature		**Theme** Relationship between science fiction and science culture	**Data sources** Science fiction literary criticism, history, and philosophy of science	**Summary** Science fiction is strongly linked to pseudoscience and has reflected social and cultural historical interests in science. The relationship and focus between science and science fiction reflects contemporary issues of the time.
Strauss, K.	2015	"These Overheating Worlds"	Qualitative	Annals of the Association of American Geographers
Focus of research Ecological issues: Opportunities to explore climate change in human geography are opened up by utopian and dystopian representations in science fiction		**Theme** Relationship between science fiction and science culture	**Data sources** "Cli-fi" and historical geography texts	**Summary** Utopias and dystopias are fundamentally spatial, stories of a better present and archaeology of the present, enabling exploration of alternative political futures and other socioeconomic systems
Toscano, A. A.	2011	"Using I, Robot in the Technical Writing Classroom: Developing a Critical Technological Awareness"	Qualitative	Computers and Composition
Focus of research How technical writing and comprehension can be enhanced beyond the practical elements by considering science fiction representations of technology in a broader cultural context		**Theme** Pedagogy/science communication	**Data sources** I, Robot by Isaac Asimov, contemporary theory on technical writing, close reading of student essays in response to topic questions	**Summary** Students must understand that technologies are not merely tools but products of culture and society before they can acquire critical technological literacy
Van Dijck, J.	1999	"Cloning Humans, Cloning Literature: Genetics and the Imagination Deficit"	Qualitative	New Genetics and Society
Focus of research Science fiction as a tool for comprehending and evaluating the scientific "imagination deficit" and associated oversimplification of science		**Theme** Pedagogy	**Data sources** Historic and current fiction regarding cloning, media reporting of cloning	**Summary** Cloning is represented in a variety of positive, negative, and neutral ways in fiction, and literary narratives are important intermediaries (between nature and science, science and culture) and rhetorical tools in the construction of public meanings and the public understanding of science.
Van Gorp, B; Rommes, E; Emons, P.	2014	"From the Wizard to the Doubter: Prototypes of Scientists and Engineers in Fiction and Non-Fiction Media Aimed at Dutch Children and Teenagers"	Mixed	Public Understanding of Science
Focus of research Identifying prototypes of scientists in juvenile media and how that may affect the image of science in society		**Theme** Pedagogy	**Data sources** Media consumed by schoolchildren—written and broadcast	**Summary** Creates seven prototypes of fictional scientists and contrasts with prototypes of real scientists—the fictional prototypes provide misinformation that is unrepresentative and often negative
Wilsing, M; Akpinar-Wilsing, N.	2004	"Integrating 'Outer Space Design' Into Design Curriculum"	Qualitative	International Journal of Art & Design Education
Focus of research Using science fiction concepts to stimulate the creative imagination of design students		**Theme** Pedagogy	**Data sources** Research on classroom experiences, science fiction literary criticism	**Summary** Science fiction is a very effective pedagogical tool for teaching design students and the use of it is to be encouraged as an aid to conventional curricular teaching.

Table 2. Thematic Classification of Publications, Number in Each Category.

Theme	Number
Connections between science fiction and human culture	12
Influence of human culture on science fiction content	3
Literary criticism	10
Pedagogy	9
Relationship between science fiction and science culture	7
Science and technology studies	7
Science communication	5
Two cultures	5
Total	58

The thematic classification of texts is shown in Table 2. The total is greater than the number of publications as 15 papers were classified as having two balanced themes.

Thematic Analysis

Cultural themes dominated the content of the publications (Table. 2). The "two cultures" debate initiated by the British novelist and polymath C. P. Snow (1961), regarding the perceived cultural gap between the natural sciences and humanities, was explicitly addressed in five papers (Brandau, 2012; Erren & Falaturi, 2009; Fendt, 2015; Hull, 2005; Miller, 2011) but was implicit in a majority of the works examined. Among cultural themes, there were clear distinctions between research examining the relationship between science culture and science fiction, which examined the influence of human culture on science fiction content, and the research that focused on connections between science fiction and human culture. The first two of these themes are bidirectional—science fiction can influence science and scientists (Dunnett, 2012; Hansen, 2004; Steinmuller, 2003), science can influence science fiction (Guerra, 2009; Kohlmann, 2014), and this relationship can be reciprocal (Coyer, 2014; Jonsson, 2013; Strauss, 2015). The theme of "connections between science fiction and science culture" indicated a less directive association: Observations of congruence rather than influence were specifically noted in nine papers (Banerjee, 2003; Geraci, 2007; Hull, 2005; Jameson, 1987; Jonsson, 2013; Kohlmann, 2014; Kotasek, 2015; Parrinder, 2009; Shaddox, 2013).

The primary discipline-specific themes were literary criticism and pedagogy, appearing in 10 and nine publications, respectively (see Table 2.). Two of the literature papers were focused on traditional close reading of specific texts (Lin, 2013; Piper, 2013). Literary criticism is an expected theme in a review of publications on fiction; pedagogy, however, was not a search term and consequently the prevalence of the use of science fiction in education and for educational purposes was a significant finding. This varied from classroom education employing science fiction texts and media as aids to learning (Larsen, 2011; Toscano, 2011; Wilsing & Akpinar-Wilsing, 2004), to observations on how science fiction has served as popular, informal, education on a range of topics; leading to both positive (Coyer, 2014; Hansen, 2004; Jonsson, 2013; Strauss, 2015) and negative outcomes (Banerjee, 2003; Geraci, 2007; Hull, 2005; Jameson, 1987; Jonsson, 2013; Kohlmann, 2014; Kotasek, 2015; Parrinder, 2009; Shaddox, 2013; Van Gorp, Rommes, & Emons, 2014), to recommendations on the use of science fiction as an effective educational medium or resource (Erren & Falaturi, 2009; McIntire, 1982; Milner, 2009; Van Dijck, 1999).

The majority of the remaining papers were classified under the closely related, but distinct, themes of science and technology studies (Bainbridge, 2004; Brandau, 2012; Fendt, 2015; Maguire, 2013; Schwartz, 2013; Sielke, 2015; Slaughter, 2014) and science communication (Carpenter, 2016; Nerlich et al., 1999), which were also connected to pedagogy in three papers (Hansen, 2004; McIntire, 1982; Toscano, 2011). The two explicitly communications-themed papers were concerned with the melodramatic and negative effect of use of science fiction tropes in media representations of science. The two papers approached this from different methodologies and came to differing conclusions. Carpenter concluded from participant observation within nongovernment organizations focused on campaigning against "Killer Robots" that tropes used from science fiction (e.g., *Terminator, RoboCop*) were effective as inducements to draw people into more fruitful debate about politically sensitive research policy, whereas Nerlich, Clarke and Dingwall found media associations of cloning with stories such as *Frankenstein* and *Brave New World* had a very negative and damaging effect on public perceptions of research. Their findings could be interpreted as illustrating that negative "diegetic prototypes" (Kirby, 2010) can be employed for sensationalist purposes. Carpenter's participant observation confirmed positive outcomes arising from the appropriation of fearful film tropes for the purpose of attracting interest in open debate of their subject matter. Nerlich et al. examined literary and media examples, more than film, and these tended to be darker and more negative—promoting fears about emerging science. The "directedness" of the authorship of these narratives is manifest: positive from expert research advocates, negative from less well informed, and sensationally invested, news media. Carpenter's paper illustrates what Jan Schwarz styles as "storylistening" (Schwarz, 2015. p. 512). The organization uses popular narratives to embody the fictional in the factual debate on robotic futures, and creates a compelling hybrid for the engagement of the public. This builds an "alternative mode of knowing" (p. 512), in which the public will discuss the factual science due to their interest in the fictional narrative, and the organization can learn more from the public. The alternative mode retains the human significance of the fictional versions, enabling future research design to include measures to address these

human concerns. Science and technology studies-themed papers tended to be more abstract; all the authors except Bainbridge examined specific aspects of science appearing in historic literature that can be related to theory. Bainbridge's paper, being a forward-looking description of the potential to employ advances in technology to aid the convergence of natural sciences and humanities, was focused on applied science. To achieve this, Bainbridge advocated using systematic semantic systems to integrate research cultures that are currently isolated. He demonstrated the practicality and effectiveness of this systems-based approach by applying it in this paper, employing quantitative analysis to support qualitative evaluation of the theory across multidisciplinary frameworks. Two other papers also utilized quantitative methodology, to apply science fiction to the interpretation of cultural change (Rabkin, 2004), and to drive innovation policy (Bina et al., 2017). The remaining papers employed qualitative or mixed methods.

The six publications that have not yet been mentioned (Ginway, 2005; Hills, 2003; Hrotic, 2014; Idema, 2015; Newell & Lamont, 2005; Rutten, Soetaert, & Vandermeersche, 2011) exhibited foci or approaches that were either very specific or not readily classifiable. Ginway discussed science fiction from the developing world, specifically Brazil, making observations on the specificity of science fiction themes and mythology to cultural values, which are valuable in demonstrating this entanglement from a perspective outside of the English-speaking tradition. Hills and Hrotic both examined modern developments in science fiction writing that reuse historic literary and cultural traditions: Hrotic suggested current disappointment in science explains the success of Steampunk literature, which hearkens back to the scientific optimism of the Victorian era, and Hills discussed Kim Newman's reuse and exploration of classic science fiction and horror literature (*Dr. Jekyll and Mr. Hyde, Dracula*) as a means of exploring modern culture in historic literary environments already very familiar to readers. The only paper with gender as a critical subject was Newell and Lamont's discussion of pre-1970s science fiction by female writers from a feminist perspective, although Hills also discussed gender concepts as regard to Newman's "queering" of the Jekyll and Hyde story. Idema concluded that futuristic, "hard" science fiction could be read as a mode of thinking with science about the future of human life. Rutten, Soetart, and Vandermeersche employed rhetorical models of analysis to describe science fiction as a "satire for living"—particularly with regard to fictional dystopias: Theirs is the only paper that applied this approach.

Discussion

There were two prominent applications of science fiction that became evident in the close examination of the publications reviewed. The first was the power of science fiction as a tool for scientific and social advocacy and cultural insight: Erren and Falaturi said that science fiction might be used "to smuggle scientific facts into the consciousness of a scientifically illiterate public" and Kotasek concluded that as society depends upon the influence of our models of reality, so science fiction has a role in "constructing such cultural and social systems also to implicate the genre as a cultural, social, and political institution."(p. 76) Nerlich, Clarke, and Dingwall agreed, "the general public uses metaphors to talk about human dignity and autonomy, and they reach back not to philosophy books but to sci-fi novels and films to underpin their arguments."(p 1.13) Bina used science fiction for "a form of forward-looking technique" that might have a significant role in influencing real-world policy. The clearest statement of this position was made by Van Dijck:

> Science Fiction, throughout the centuries, has been a significant cultural tool for comprehending and evaluating the scientific, moral and social consequences of new technologies . . . besides projecting a possible future, science fiction often entails criticism of present technological or social arrangements. (p. 9)

The second major application was in the enhancement of learning and teaching. Research undertaken on this subject demonstrated a broad range of applications and was predominantly positive when the use of science fiction as a pedagogic tool was integrated purposefully into the curriculum. Toscano notably employed science fiction to educate students about good technical scientific writing: the most efficient combination of pedagogy and communication that was found in this review. The exception was Van Gorp's study, which was focused on passive, observational, learning absorbed by the subjects from the representations of science through fictional representations of science and scientists across a range of media. This was found to lead to negative or inaccurate views of science and scientists. In contrast, however, Hansen's analysis of comic book portrayals of science in the 1940s suggested that media representations could have positive impacts. In a formal, directional, context, the pedagogical applications are varied and have a measurable beneficial impact. Therefore, classroom use of science fiction provides valuable tools to both encourage interest in science and to inspire scientists, but passive absorption of science fiction concepts that cross over into real science is more problematic.

Considering the demonstrable impact of research applications of science fiction content and concepts, the small number of quantitative methodologies found in the review is significant, as is the variable quality of their implementation. Bainbridge provides a cogent and well-structured methodological example of the potential for science fiction to be an insightful and meaningful tool, and employs quantitative methodologies to analyze chaotic and granular data of the sort that is found in cultural studies. The strength of Bainbridge's multidisciplinary research in semantics is

evident in the consistent quality of his methodology. Rabkin's study included the intent to remove qualitative selection bias by engaging a pool of researchers from the field of literature to apply content categories to stories so that they could then be analyzed quantitatively. Yet, predefinition of coding categories appears to have constrained the freedom of analysis. For example, a strong correlation between the categories of genre form "alien contact" and genre content "alien" was one of the "provocative results" (p. 466) described in the findings, but such a correlation is naturally predicated at a one-to-one ratio in science fiction narratives. The study findings would arguably have been strengthened by identification of the statistical insignificance of this correlation by members of a multidisciplinary research team. Bina et al. applied iterations of subjective criteria to identify films and novels that were analyzed mathematically to create new suppositions, but the methodology is not described in replicable detail, and may have been subject to confirmation bias arising from the use of online databases to validate the selection. Using quantitative tools to analyze research findings in fields that have traditionally been dominated by qualitative methods is constrained by access to expertise. During the design and execution of the project, engaging experts from outside of the author's own specialism may improve the application of quantitative methodology to humanities research. The application of techniques such as data and text mining, robust statistical and structured methodological analysis, to studies that are traditionally located in the humanities would support the convergence between the arts and sciences, and the breaking down of the perceived gap between them that was highlighted by Snow in 1961. For analysis of literary content to become a credible tool in broader research contexts, a stronger focus on the use of quantitative, replicable, methodologies is to be recommended.

Conclusion

Science fiction has been used as a metaphor and as an illustration of human culture by researchers in fields that are not restricted to studies of science fiction literature. As such, there are indicators that science fiction is employed as a lens through which human culture may be viewed to discover new interpretations. These may be relevant to cultural, social, scientific, and literary studies, and support efforts at improving science communication, and especially science education. Researchers described the effectiveness of popular science fiction in capturing the imagination of the public, and creating unrealistic portrayals of science and scientists. This has both positive and negative impacts on science communication, and may even affect priorities in science funding. It seems that in the public imagination, science fiction is closely linked to real science, and this can be problematic for the dissemination of research. Rather than ignoring these links due to their fictional origins, it is necessary to engage with the public to learn about their hopes, fears, and

expectations of science, and to consider how science fiction may be employed for diegetic purposes. Raising awareness among scientists of the significance of these factors may build researcher capacity for successful science communication. Convergence of research between the humanities and natural sciences may be one route to supporting and encouraging more positive communication with the public, the credibility and efficacy of interdisciplinary science, and consequently more efficient and beneficial outcomes of research. This convergence should be driven by the increased application of structured and quantitative methodologies to the analysis of science fiction, and other traditionally humanistic forms, now that the technology exists to do this effectively and rapidly, to reduce the researcher bias in selection and interpretation of sources that is at the heart of the rejection of humanistic approaches by natural scientists. This breakdown of barriers is especially important when we consider the human, cultural perspective that can be added to hard sciences by this method, and how this may affect the effectiveness of science communication and the reputation of science in the minds of the public. The time is now for the integration of hard science methodology into the humanities.

Authors' Note

Christopher B. Menadue developed the initial concept and performed database searches. Menadue took the lead role in data analysis and drafted the article. Both authors edited and revised the draft article and approved the final article. Richard Lansdown, Komla Tsey, and Susan Jacups provided editorial input.

Note

1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Liberati et al., 2009; Stevens et al., 2014).

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Author Biographies

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