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The impact of Science Literacy delivery methods - what works?

Strengths, Weakness, Costs and Feasibility

GROUP 3. Traditional publishing and journalism - print and broadcast

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NOTES
n.d. = no data provided

GROUP 3. Traditional publishing and journalism - print and broadcast

Mechanism	Content of use	Strengths	Weaknesses	Costs and feasibility	Notes	Reference
17. Animations (+ Games & Simulation)	Statistics [Interdisciplinary science]	Animations go beyond static representations to provide more powerful graphical representations which display sequences of images creating an illusion of movement. This can facilitate our understanding of two and three dimensional properties of distributions and assist our understanding of changes across time or space. The activities provided by games, animations and simulations provide active approaches to learning which are consistent with modern ideas about how best to teach research methods and statistics.				**A narrative literature review of games, animations and simulations to teach research methods and statistics** Boyle et al. 2014
18.Books						**NO REVIEWS**
19.Brochures						**NO REVIEWS**
20. Cartoons	Science education [Social science]	Significant features of Concept Cartoons include: - they are based on everyday situations that don't appear to be scientific, so students lacking in confidence are less likely to be intimidated by the science and more likely to engage with them. These everyday situations appear to be effective across geographical and cultural boundaries, enabling				**Concept Cartoons: What Have We Learnt?** Naylor and Keogh 2013

| | | Concept Cartoons to be used successfully in a wide range of countries
- they present alternative viewpoints on the situation, including the scientifically acceptable viewpoint(s). Most Concept Cartoons embed scientific ideas in everyday contexts, and the contextual features can influence how the problem is interpreted, so that in many cases there can be more than one scientifically acceptable alternative. This presents an additional level of challenge to learners, especially to high achieving students
- the cartoons have a blank speech bubble, to give a clear statement that there may be more ideas that are not yet included in the dialogue so that learners are encouraged to explore alternative ideas
- the background text is written in students' language, so they can be used independently by learners if the teacher feels that this is appropriate. This extends the range of ways that teachers can choose to use Concept Cartoons in their classrooms
- all alternative viewpoints have equal status. When the teacher presents a set of alternative viewpoints in a Concept Cartoon, all of these viewpoints are seen as legitimate. This gives less confident students support in voicing what they think, because someone else | | | | |

		has already articulated their ideas. If their ideas are incorrect they can put the blame on the Concept Cartoon character. (...) - the speech bubbles include common misconceptions, so these can be recognised and addressed directly in the lesson. Some teachers are concerned that raising misconceptions may make students more likely to believe these, but research indicates that this does not happen in practice and that Concept Cartoons can be a very effective way to challenge misconceptions - they present plausible alternatives that are based on research evidence about students' ideas at different ages - Concept Cartoons act as an effective stimulus for argumentation, including enabling students to co-construct arguments - Concept Cartoons have been used as an effective means of auditing student teachers' subject knowledge, so enabling them to identify where they need to develop their ideas further - the nature of Concept Cartoons means that they are not identified exclusively with formal learning settings. They can bridge the gap between formal and informal learning settings because they are based around everyday situations that appear to involve ordinary characters doing ordinary things			

		- the pictorial representation of ideas, coupled with minimal text, makes it relatively easy for learners to engage with Concept Cartoons in a language that is not their home language. This addresses the fact that it is widely recognized that language can be an important barrier to learning in science.				
20. Cartoons	Health, health education [Healthcare and Medicine, Social science]	Pictographic representation is beneficial for comprehension and communication in health care. The most common pictographic health education materials featured black and white simple-line drawings with simple text. These pictographic health education materials helped to make the information understandable and successfully conveyed healthcare messages to people with health literacy. In the medication studies, pictographs with simple text increased the recall of instructions, were successful in communicating medication information, were easy to understand and helped patients remember medication information. Pictographic health education was reported to be effective regardless of race/ethnicity.				**Effectiveness of using picture-based health education for people with low health literacy: An integrative review** Park and Zuniga 2016
21. Comics	Pharmacy, Health	Comic books could be a visually interactive and innovative		Other benefits of using comic books in the	(...) there is still resistance to the use of this genre as a	**An Overview of Comic Books as an Educational**

	education [Healthcare and Medicine, Social science]	educational tool. Pharmacy faculty could use comic books or graphic novels as stand-alone texts or as part of a larger curriculum. Comic books could help students learn pharmacy-relevant content while enjoying the reading. (…) comic books appeal to a wide audience across all age and ethnic groups because they employ an everyday language that is almost universally understood and can be concurrently instructive and entertaining. A sophisticated yet simple use of visuals and text in comic books in generating a clear narrative for the information to be presented gives comics the potential to go beyond the traditional textbook for teaching and learning. The comic format allowed for the integration of concepts, such as empathy, which may not have been possible through traditional text.		classroom setting include their low cost, ease of portability, familiarity with the format, and use of a language that can be understood by all age groups and across ethnic groups.	pedagogical tool in some circles at university level. Educators have lined up on both sides of the debate. Most of the resistance is because a combination of text and images is considered fine for children's books, but not for college education where students are expected to read "real books." Comic books or graphic novels are a creative way to teach and learn about illness, patient experiences, and other related topics. They are a largely untapped source that may be uniquely suited to Generation Y and helpful in cultivating behaviours related to patient-centeredness, professionalism, altruism, and ethics.	**Tool and Implications for Pharmacy** Muzumdar 2016
21. Comics	Health [Healthcare and Medicine]	Comic books can be a useful tool for education in public health crisis, especially in areas with high rates of illiteracy. Comics have a long tradition of sharing information through images without having to rely too heavily on text. Comics books are also low cost, easily portable, and don't require electricity or other			Comic books in public health in many ways mirror the growth of comic books as a media, growing from material that is simplistic and meant for children to material that can have depth and be intended for adults. In a public health crisis comics have potent to be	**Quantifying and Visualizing the History of Public Health Comics** Schneider 2014

					helpful media material that can be readily accessible. Unfortunately too many comics are not archived appropriately.	
21. Comics	Science education, science communication [Social science]	The research reviewed in this paper strongly suggests that comics have great potential for engaging wide and diverse audiences with STEM subjects. Combining the benefits of visualization with powerful metaphors and character-driven narratives, comics have the potential to make scientific subjects more accessible and engaging for a wider audience. From an educational perspective learning from comics may offer several advantages. First of all, most comics are built on the integration of text and pictures, which was highlighted by Mayer and colleagues as a guiding principle of textbook illustrations (Mayer and Gallini, 1990; Mayer et al., 1995). Moreover, the multimodal nature of comics has the potential to increase readers' engagement and facilitate learning. Finally, comics often rely on the use of characters and situation models, which provide the basis for emotional attachment and self-reference, which can also facilitate the formation of new memories.				**The potential of comics in science communication** Farinella 2018

		(...) However, when it comes to science communication, visuals which require high degrees of expertise in order to decipher the information contained may not be particularly helpful. However, visual narratives, such as comics, may offer a way to bridge this gap. Narratives have been proposed as a useful tool to address sensitive subjects, which may otherwise resist cognitive elaboration because of conflicting beliefs and/or lack of interest amongst the audience. Moreover, because their cause-effect structure, narratives are intrinsically easier to remember than expository arguments and the changes of beliefs induced by narratives appear to increase over time, the so-called 'sleeper effect'. Finally, several studies show that these effects are resistant to various forms of manipulation: unless the persuasive intent of a narrative is made explicit or the message is subjected to an active scrutiny, narratives seem to be largely assimilated as 'facts' even when explicitly labelled as 'fiction', and the message they carry can have long-lasting effects on the beliefs and behaviours of the reader. Therefore, one of the main benefits of comics in science communication could be the mapping of abstract				

		scientific concepts on to everyday objects and experiences, helping the public to engage with the material at a more personal level.				
22. Games	Health promotion [Healthcare and Medicine]	Games can be used in health promotion and as a channel to engage those who are hard to reach with traditional health education methods. Digital games also have other benefits: games are engaging, and they offer opportunities for social interaction and practice of different skills in a safe environment and provide individualized feedback. In general, children are interested in games regardless of age, gender, and background. Thus, games could turn out to be a remarkable resource in children's health promotion. The most promising evidence seems to support children's use of digital games in health education related to asthma and diabetes behaviour and diet-related habits.	The reason for the small amount of research related to sedentary games may be that there are many commercial active videogames in the market and fewer sedentary health games.	Sedentary games require a lot of resources (e.g., a multidisciplinary team, substantial expertise, creativity, time, and funding) for the development process before an evaluation is even possible, and that makes conducting research complicated.		**Promoting Children's Health with Digital Games: A Review of Reviews** Parisod et al. 2014
22. Games	Diet & Nutrition [Healthcare and Medicine]	Digital games are an emerging intervention strategy to improve personal health. These health games often use the principles of 'behavioural change models' from psychology to motivate their users to adopt healthy behaviours such as adopting a better diet.			Perhaps more intensive collaborations between interdisciplinary academic researchers and commercial game companies would mutually propel both fields of health game research and health game production forward.	**Digital games for nutrition and healthy eating** Lu, Kharrazi, and Baranowski 2016

22. Games	Science education [Social science]	Several classes of video games can be viewed as a type of cultural tool that is capable of supporting three key elements of scientific literacy: content knowledge, process skills, and understanding the nature of science. The authors argue that there are three classes of mechanisms through which video games can support scientific thinking. First, there are a number of motivational scaffolds, such as feedback, rewards, and flow states that engage students relative to traditional cultural learning tools. Second, there are a number of cognitive scaffolds, such as simulations and embedded reasoning skills that compensate for the limitations of the individual cognitive system. Third, fully developed scientific thinking requires metacognition, and video games provide metacognitive scaffolding in the form of constrained learning and identity adoption. Games may serve as a useful cultural tool through which instruction can effectively make use of existing capacities. A player's abilities or knowledge of the game are constantly assessed; if the player does not perform well-enough in the game, she fails. This is because games are essentially a		Incorporating games into science instruction requires careful consideration of their strengths (e.g., intrinsically motivating) and weaknesses (e.g., unclear links to science content). In order to achieve maximum benefit, like any tool, games need to be used at the right time in the right way.	"Gamification" of particular elements of science education is one of the components that the authors feel has the potential to contribute to modern.	**Gaming science: the "Gamification" of scientific thinking** Morris et al. 2013

| | | demonstration of a player's skills. This form of assessment is, of course, different from traditional educational assessments. Games provide an authentic context in which players can demonstrate what they have learnt, in contrast to standardized tests.

The authors agree that video games can be used to scaffold internal factors, such as motivation, cognitive skills, and metacognitive skills, while also providing constrained and directed use of cultural tools, such as recording prior behaviours and outcomes, and providing task-relevant knowledge.

The authors suggest that video games should be considered a type of cultural tool that can be used to scaffold science learning. Specifically, they proposed that video games have the potential to facilitate learning both science content and science process skills. Further, they suggested that elements of video games (e.g., they are intrinsically motivating and often make use of elements of science process) could be used to improve classroom-based science education.

Authors further suggested that games are cultural and educational tools for science education and that | | | | |
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		games have unique strengths that can be used to augment science education.				
22. Games	Education [Social science]	Games-based Learning (GBL) has developed a reputation with educationalists and is perceived as a potentially engaging form of supplementary learning that could enhance the educational process. Games have been used at all levels of education including primary, secondary and tertiary education.				**A systematic literature review of games-based learning empirical evidence in primary education** Hainey et al. 2016
22. Games	Education [Social science]	The findings suggest that the learning experience [through games] is considered more sensory and playful if the learning content is accessible through a selection of virtual characters, environments, narratives, and multimedia elements. These elements are integrated to facilitate attention and to promote the player's interest, which in turns triggers his/her engagement, providing opportunities to observe and browse visuals but not to read. However, these features are essential because they make it possible for students to experiment and make discoveries. - GBL helps students to develop skills and knowledge and strengthens their ability to handle the learning experiences provided by the games - in the GBL context, engagement is	- gameplay must be supported with appropriate feedback and scaffolding; these can be provided in various forms depending on students' learning requirements.	Gaming activities must match students' gender, game type preferences, and preferred mode of gameplay, as well as their abilities and the games' learning tasks.	Clearly, the papers indicate there are no specific rules to gameplay experiences. The impact of gameplay, in terms of engagement and learning, depends on players' individual differences (i.e., gaming proficiency, personality, preferences, and emotional state). Thus, engagement, when it comes to learning, may be seen as a personal process.	**Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review** Abdul Jabbar and Felicia 2015

		related to students' cognitive and emotional involvement in the gameplay - multirole-play or collaborative role-play works effectively when coupled with learning tools and interactive elements and materials to motivate and help learning.				
22. Games	Science education [Social science]	Learning occurs naturally while playing games. Based on this literature review, several potentials of using digital games to promote science learning are proposed: - enhance learning by connecting game worlds and real worlds - facilitate collaborative problem-solving - provide an effective environment for science learning.				**Game-Based Learning in Science Education: A Review of Relevant Research** Li and Tsai 2013
22. Games	Science education [Social science]	Video games can offer virtual environments in which players can become absorbed and engaged in the embedded science learning activities, such that they carry out the tasks with considerable enjoyment and fulfilment. Serious Games (SGs) may play various roles in improving students' science learning, and science instructors should be sensitive to the pedagogical role of a given SG used in a given science class.			To make effective use of serious games in science education, collaborations among science educators, science instructors and serious game designers will be a crucial but challenging issue.	**The use of serious games in science education: a review of selected empirical research from 2002 to 2013** Cheng et al. 2015

		Video games provide contexts where the human mind can be exercised and playing good video games in itself is a process of thinking and learning.				
22. Games	Science education [Social science]	Teachers can rest assured that although it may seem like 'play', when done with fidelity and true consideration of students' needs and teachers' goals, online learning in the form of e-book and online maths games in the elementary classroom can lead to greater student achievement.				**The effects of on-line math games and e-books use on elementary student achievement** Carnahan 2014
22. Games (+ Animations & simulation)	Statistics [Interdisciplinary science]	The activities provided by games, animations and simulations provide active approaches to learning which are consistent with modern ideas about how best to teach research methods and statistics.			The review revealed that there are currently few rigorous evaluations of game-based approaches in this area, although the general thrust of the evidence was positive and there is reason to be optimistic about the potential of a games-based approach. Progress will be made by looking in more detail at how the characteristics of games, both at the higher level of game genre but probably more usefully at the lower level of game mechanics, lead to more effective learning.	**A narrative literature review of games, animations and simulations to teach research methods and statistics** Boyle et al. 2014
22. Games	Health promotion	It was argued that computer games designed to support learning have				**Games and Diabetes: A Review Investigating**

	[Healthcare and Medicine]	many advantages, and could be especially important for children with diabetes because diabetes, if not well controlled, can be life-threatening.				**Theoretical Frameworks, Evaluation Methodologies, and Opportunities for Design Grounded in Learning Theories** Lazem et al. 2016
22. Games	Education [Social science]	At a deeper level, games provide learners with opportunities to collaborate, problem-solve, and to develop a sense of place in a simulated world through self-discovery. Games can help contribute rich experiences that are often not found in a traditional classroom setting, and those experiences can provide skills that students need in the twenty-first century.				**Game Design and Homemade PowerPoint Games: An Examination of the Justifications and a Review of the Research** Siko and Barbour 2013
23. Graphics						**NO REVIEWS**
24. Posters	Health promotion [Healthcare and Medicine]	The poster presentation is a commonly used format for communicating information within the academic and public health fields.\n\nPoster presentations are beneficial to conference organisers, authors and delegates in several domains.\n\nAt first glance, posters seem relatively inexpensive to produce, given that they can provide the audience with information that can be viewed by a number of individuals at their own pace.	The graphical design and physical appearance of the poster can determine its success in promoting knowledge transfer.\n\nPoster presentations are not well equipped to accommodate alternative learning styles. Whilst an audience may consist of those who best learn when reading information, a poster also needs to provide clear navigation in order to provide a sequential logic.\n\nGiven its passive nature; if not accompanied by an active intervention (e.g. oral presentation,		Based on current evidence, users should not use a standalone poster in an attempt to achieve knowledge transfer – rather, an integrated approach with supplemental material is required to achieve changes in user knowledge, attitude and behaviour.	**What is the evidence that poster presentations are effective in promoting knowledge transfer? A state of the art review** Ilic and Rowe 2013

		Posters provide the viewer with a concise overview of a project/topic, which may often be supplemented by informal discussion with the author. When delivered in combination with a short presentation or author presence, a poster presentation can facilitate informed discussion between the presenter and audience. This combined process may be more engaging, and a means by which the poster presentation can promote active learning. Additionally, such discussion and networking opportunities are often the catalyst for future collaborative efforts, and add to the overall objectives of conference attendance.	physical interaction), which can help with aural and verbal learning exchange, the 'traditional' poster may only reach a limited proportion of its intended audience. Whilst the production of a poster may seem relatively simple and inexpensive, the reality is that presenting a poster is quite expensive in terms of the man hours, publishing costs and travel expenses required to present it at various forums.			
25. Publications						**n.d.**
26. Radio						**NO REVIEWS**
27. Reports						**NO REVIEWS**
28. Television	Health and Health promotion [Healthcare and Medicine]	Despite the dominating and expansive role of the Internet, global reports on mass media still find television as the most popular source of information on health. The television presents itself as a promising source of information on the topic of health and illness which, provided one maintains a cautious attitude as well as moderation, influences the level of	On the one hand, this mass access may be a blessing, on the other – a curse as the strength of the broadcast messages is not the content but the mere fact of making it public. Thus, many researches of the medium express their justified concern and underline low quality and insufficient factual level of television messages which refer to the topic of health.		Therefore, appropriate distance and moderation is also recommended in such formats as: reality shows and talk-shows devoted to health issues.	**Television as a source of information on health and illness – review of benefits and problems** Burzyńska, Binkowska-Bury, and Januszewicz 2015

| | | knowledge of the viewers, identification of simple symptoms and constitutes an important source of education in terms of prevention and avoiding risk behaviours.

(...) television introduces a new dimension to health education and is perceived as a serious source of health and illness information. Its undisputed asset of accessibility and range make it possible to reach a vast and diversified group of viewers.

However, it is undeniable fact that the accessibility of television allows various social groups regardless of age, education and place of residence to receive health-related messages. A wide spectrum of television formats which contain health information increases the probability of encountering such content every time the viewer decides to turn on their television set.

(...) The presented review of available studies shows that medical television series may educate viewers in terms of: identifying some symptoms of an illness, getting to know the reality of hospital life, understanding diagnostic procedures, observing the duties of doctors and medical personnel. What is more, some | Nevertheless, the recipients ought to be aware that the series are fiction features and do not aim to faithfully reflect the reality (despite consulting specialists), that is why, one should not overly believe the situations presented on the screen. One needs to be aware of their entertaining character and to treat information they convey with caution. | | | |

		series also provide valuable educational material for students of Medicine as well as serving as a support in the medical practice of doctors and specialists.				
28. Television	Health education [Healthcare and Medicine, Social science]	Dramas and movies can be continuously and affordably distributed as streamed content. Entertainment is one of the last frontiers for health communication. Entertainment education (EE) has been developed for its efficacy in health campaigns in developing countries, where traditional text-based literacy is limited. In developed countries, EE has been explored and elaborated extensively in empirical research. Recent rapid change in the entertainment industry, facilitated by Information and Communication Technology (ICT) expansion in developed and developing countries, has increased audiences' ease of access to entertainment narratives such as feature films and border-free TV productions. Entertainment narratives can arguably become a health information source for audiences around the world.	Narratives may convey both negative messages (e.g. scenes of smoking, violence, and unsafe sex) and positive messages (e.g. scenes of safe sex, healthy diets, and non-smokers).			**Mapping research on health topics presented in prime-time TV dramas in "developed" countries: A literature review** Kato et al. 2017
29. Videos		(Para. 4.3) Video shows great potential as a mechanism for the delivery of scientific literacy, due to a variety of qualities of this	(Para. 4.4) The predominant weaknesses related to the use of videos as a mechanism of delivery are associated with infrastructural	(Para. 4.5) With regard to costs and feasibility, the technological affordability of videos and their	(Para. 4.6) The establishment of complementary extension methods such as	**http://www.nida-net.org/en-gb/activities/connectwiths**

		approach. Firstly, it allows for multimodal opportunities to learn, teach and present ideas, providing a meaningful and enriching way of supporting and/or supplementing learning, and is particularly useful for meeting specific educational needs, for example for individuals with low literacy levels or for communicating abstract concepts that are challenging to demonstrate in classrooms. Secondly, videos can be paused, rewound and replayed as needed, supporting repeated and self-paced viewing to support learners. A third advantage is that videos can serve as a less-resource intensive tool to provide standardized content across learners, and can be made available and accessible through a variety of technologies and online platforms. A review of the reported impacts of video interventions suggests that videos have tremendous potential as a tool for agricultural extension, farmer-to-farmer exchange and health literacy in developing countries.	constraints, i.e. the reliance on power and connectivity, affordable access to the internet and mobile/smartphone ownership and use, particularly in rural and resource-deprived contexts. Other studies highlighted that the effectiveness of video interventions was dependent on additional instructional scaffolding around the intervention: including instructor facilitation, materials and participant activities (discussion groups, etc.). Other studies highlighted the importance of physical location and timing of videos in order to enable inclusive participation (e.g. greater involvement of females in rural areas, etc.).	flexibility of potential use and scalability across multiple platforms, technologies and devices can make these interventions affordable and cost effective to access, particularly in low resource settings. Videos can also be readily modified and edited to allow use and application across diverse cultural settings.	demonstrations, field-days and farmer exchange visits could provide greater opportunities for making videos that contain adapted technologies and farmer innovations for future scaling-up. In a future scenario, a possibility could be to tailor the content and presentation to the user in order to reduce unnecessary friction for the viewer, for example by customizing the presenter's age, gender, clothes and language, depending on the location and context in which the instructions are presented.	**cience/research/reports-and-bibliographies/videos/**

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