Designing an Information Comic

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Abstract

This study revolves around the idea that using the visual language of comics to communicate scholarly knowledge benefits learners in higher education. The researcher transformed the written academic prose of pages 58-70 of Mayer's Multimedia Learning *(2009) into a 12-page information comic with help of expert informants and found that it is possible to create an information comic that communicates academic ideas provided the researcher has 1) a high level of visual literacy, 2) accepts that intersemiotic translation always leads to new meaning, 3) accepts that emotion will become part of the final product, and 4) accepts that it takes considerable time to create the imagery. Based on the literature, experience and expert feedback, the researcher identifies 12 possible steps for the design of information comics and six reasons why information comics demonstrate great potential for learning.*

Keywords: Information Comic, Academic Communication, Multimedia Learning, Emotive Design.

Introduction

We live in a visual culture where images have become central to communication and meaning-making (Felten, 2008), yet most academic knowledge is offered to students in verbal form. Why? "If students are to create meaning through visual interpretations, then teachers need to create didactic designs that support development of visual literacy abilities of the students" (Pettersson, 2020, p. 37). To demonstrate that scholarly knowledge can be communicated more visually I translated formal academic prose into the visual language of comics. I chose to redesign the content of *Multimedia Learning* (Mayer, 2009) because it revolves around the idea that people learn better from words and pictures than from words alone. I focus on the pages that deal with how multimedia learning works. The resulting information comic will introduce students to the idea that there are more ways into knowledge than the print-based tradition of wordy papers (Ball, 2004) and increase their visual literacy (Cohn, 2003).

My research questions are:

1. How can I translate the written academic prose of page 58-70 of *Multimedia Learning* (Mayer, 2009) into the visual narrative of a digital information comic?
2. How can I simultaneously create a learning tool for students in higher education?

Exposing students to comics might even encourage them to use it as a means of expressing themselves, as the PhD comic does (Figure 1). Comics are fun!

Figure 1
The PhD comic, a comic about grad school experiences (Cham, 2015)

Note. Retrieved from: https://phdcomics.com. Copyright 2015 by Jorge Cham

Review of the Literature

The following sections will take you through some of the pertinent literature on visual language in comics, information comics in relation to multimedia learning, and — because a verbal text is reimagined into the comic format — intersemiotic translation.

Visual Language of Comics

The existence of visual language has been confirmed by numerous studies (e.g., Avgerinou, 2001, Moore & Dwyer, 1994; Pettersson,1989). Visual language is holistic, must be learned, may improve learning, is not universal, and often needs verbal support (Avgerinou & Pettersson, 2011). The idea that comics are written in visual languages of their own may be controversial (Grennan, 2017; Hick, 2012) but many aspects are systematic and conventionalized (Cohn, 2013; Jüngst, 2010). Comics are multimodal texts. Meaning flows between two semiotic systems. "The image includes reference to the text and the text is referring to the image" (Gignoux 2005, cited in Aktulum, 2017, p.34). Eisner (1985) illustrates how meaning of the visual affects meaning of the verbal in comics by combining five facial expressions with five sentences (Figure 2). All 25 combinations have a different effect on the reader. Effective multimodal authors move the emphasis backwards and forwards between the various modes to convey the required meaning (Cope & Kalantzis, 2009).

Figure 2
Interaction between visual and text (Eisner, 1985: p.110)

Information Comics as Multimedia Learning Tool

Information comics are didactic-instructive instruments that help the reader to acquire knowledge (Jüngst, 2010). Well-designed information comics are likely to facilitate learning because "people learn better from words and pictures than from words alone" (Mayer, 2001, p.1). Mayer calls this the multimedia principle. He proposes 12 design principles for effective multimedia instruction (Appendix I).

Rasch and Schnotz (2009) call the multimedia principle into question. They suggest that adding pictures to text is neither beneficial nor harmful for learning, and that learning from text only could be more efficient. Is it possible their learners spent more time with the visuals because they enjoyed it? The role of emotion in instructional design is gaining attention (e.g., Mayer & Estrella, 2014) as affective processing is found to be linked to learning (e.g., Plass & Kaplan, 2016). Information comics popularize knowledge transfer and make extensive use of emotive elements in both text and image (Jüngst, 2010). They have the potential to increase readers engagement as well as foster scientific literacy (Eilam & Poyas, 2010; Farinella, 2018) and visual literacy (Cohn, 2013), a skill that must be learned (Avgerinou & Petterson, 2011) and is of critical need in today's universities (Kędra, 2018).

Some readers may have the conviction that comics are for children and that knowledge is oversimplified (Jüngst, 2010; McCloud, 2000), but artist-researchers like Farinella (Figure 3) and Sousanis (Figure 4) show that the comic format is suitable for communicating academic knowledge. Their success illustrates the idea that the ideal writing process occurs when researcher and creator are the same person. This shortens the distance between the idea and its translation (Eisner, 1996; Jüngst, 2010; Tatalovic, 2009).

Figure 3
Neurocomic, (Farinella & Roš ,2013: p. 45), nominated for best science book of 2014
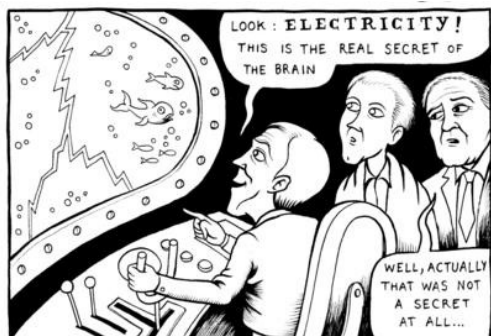
Figure 4
Unflattening (Sousanis, 2015: p. 6), winner of the 2016 Professional and Scholarly Excellence award


Intersemiotic Translation

Texts can exist in any medium. They may be verbal, non-verbal, or both. Each medium comes with its own affordances and limitations. "All texts are an assemblage of signs constructed (and interpreted) with reference to the conventions associated with a genre and in a particular medium of communication" (Chandler, 1994. p.1). When a text is taken from the original context — the prototext — and recontextualized into a new form of expression — the metatext — you must make interpretive choices (Farahzad, 2009). This means that translating a text always leads to new meanings (Alvarez et al., 1996; Bassnet et al., 2006; Eco, 1986). Van Leeuwen (2008, p. 17) describes four different possible transformations in the process of recontextualization: substitutions, deletions, rearrangements, and additions. Jakobson (1959) makes a distinction between interlingual, intralingual, and intersemiotic translation:

1. Intralingual translation or rewording is an interpretation of verbal signs by means of other signs of the same language.
2. Interlingual translation or translation proper is an interpretation of verbal signs by means of some other language.
3. Intersemiotic translation, or transmutation, is an interpretation of verbal signs by means of signs of nonverbal sign systems

Creating the information comic will be an intersemiotic translation. Intersemiotic translation is a complex form of action. Dusi (2015) describes it as "A transcultural, dynamic and functional event caught between the requirement to remain faithful to the source and the need to transform it into a text that is understood and accepted in the target culture" (p. 183). Queiroz and Aguiar (2013, 2015) propose two models of Intersemiotic Translation, Figures 5 and 6. They base their models on Peirce's (1931) famous idea that signs are a unity between Sign (S), Object (O), and Interpretant (I). (S) is the form in which the sign is presented, (O) is what the sign represents, and (I) equals the sense made of the sign. Meaning is the consequence of the triadic inter-relations of S–O–I as a whole.

Figure 5
First model: Triadic relation in which the sign (S) is the translated work, the object of the sign (O) is the object of the work, and the interpretant (I) is the translator sign (Queiroz & Aguiar, 2015)
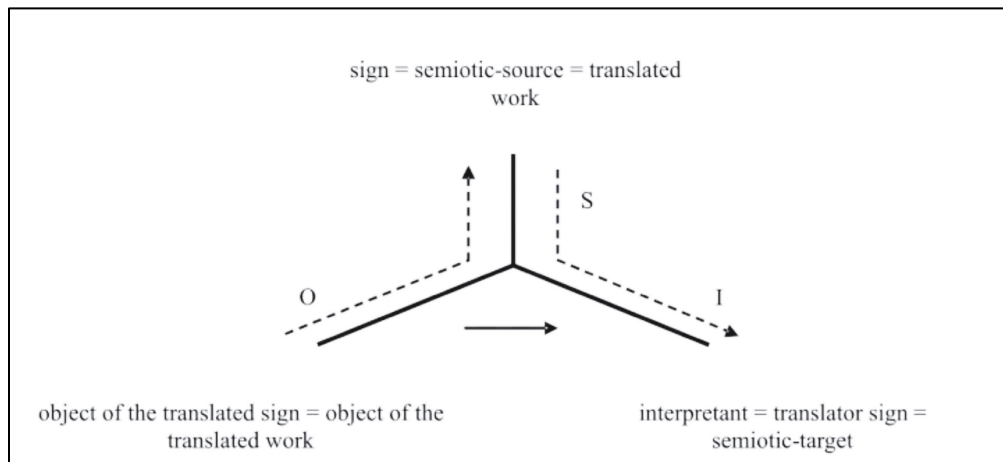
Figure 6
Second model: Triadic relation in which the sign (S) is the target, the object of the sign (O) is the translated work, and the interpretant (I) is the interpreter (Queiroz & Aguiar, 2015)
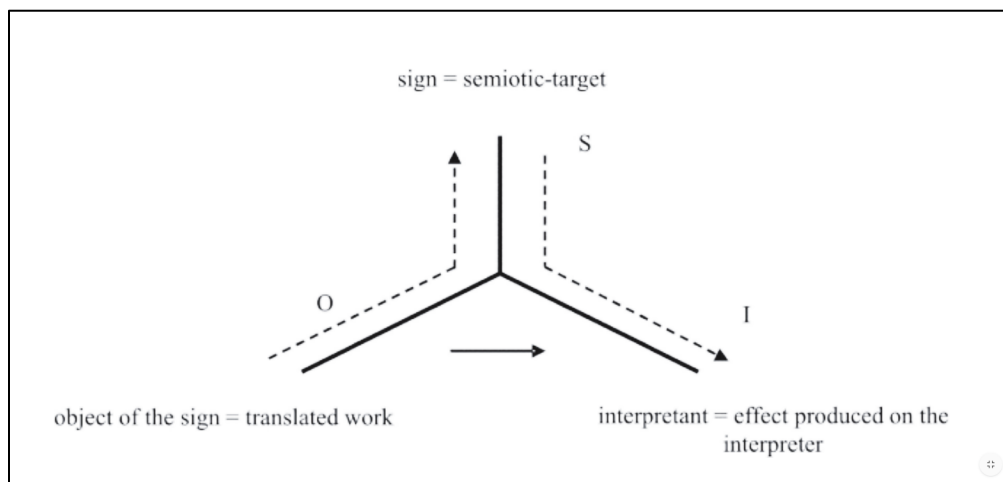
Methodology

I intended to produce an information comic on *Multimedia Learning* (Mayer, 2009), and arrive at a rationale for translating formal academic prose into a visual narrative. Data consisted of the comic, notes in my research journal and written feedback from different experts. The data itself gave rise to the theory that was constructed through qualitative analysis, in line with the constructivist model of grounded theory (Charmaz, 2006). This approach was chosen because of its unforced, interpretative accounting for all the data. After all, design is iterative, intuitive, and hard to capture in a model. A possible risk was that the emergent theory is not transferable to other situations and eventually becomes a narrative rather than an explanation.

Methods for Data Generation and Data Analysis

I translated page 58-70 of the prototext into the metatext. The design of each page was influenced by what the previous one revealed about the potential of visuals as information carriers. The research journal documented the different stages of drawing, feedback from expert informants, and my own developing

understanding. The expert informants were selected based on their potential to yield insights from the perspective of multimedia learning, the cognition of sequential images, comic design, and working with students in higher education (Table 1). McCloud looked at the completed metatext as a stand-alone comic to answer my question about realism. Brown and Dr. Jüngst commented on the pages throughout the design process. The other experts were asked for general feedback and received the completed metatext and a PDF of the prototext. Two experts received a specific question. I asked Dr. Mayer if his ideas were represented correctly and Dr. Jüngst if she considered the final product an information comic.

Table 1
Overview of informants.

Angle	Field of Expertise	Name
Multimedia Learning	*Educational psychology*	Richard Mayer
Teaching in Higher Education	*Lecturer in Multimedia Learning*	Susan Brown
	Lecturer in Education	Amanda Banks-Gatenby
Comic design	*Neuroscience, cartoonist*	Matteo Farinella
	Comics theorist, cartoonist	Scott McCloud
Cognition of sequential images	*Psycholinguistics*	Neil Cohn
	Sociolinguistics, Semiotics	Heike Elisabeth Jüngst

Ethical Issues

Multimedia Learning (Mayer, 2009) is a copyrighted text. Translating parts into a visual narrative count as an adaptation of the work, which is a restricted act according to section 21 of the Copyright Designs and Patents Act (1988). Adaptations that are used as illustration for teaching do not need permission from the copyright holder, but only when use is considered "fair" (UK Copyright Law - CopyrightUser.org, 2020). Fairness is not defined in law. Fairness is usually judged by how much work is adapted, to what audience the work is communicated and the impact on the market value/salability of the original. The issue was solved by the copyright owner, Richard Mayer, who kindly agreed to let me use his work for research purposes.

Results and Discussion

The prototext was successfully transformed into the metatext, the information comic (Appendix II). I was able to translate the written academic prose of pages 58-70 of *Multimedia Learning* (Mayer, 2009) into the visual narrative of a digital information comic (RQ1) and simultaneously create a learning tool for students in higher education (RQ2). Subsequently, I formulated guidelines based on experiences in the developmental process.

Meaning

To create the information comic I had to substitute, rearrange, delete, and add to the prototext. The academic meaning is left intact. Figure 7 illustrates how academic meaning of the comic is determined by the content of chapter three — "The science of learning" — through mediation of the book *Multimedia Learning* (Mayer, 2009). The author of the prototext, who is the expert on both content and book, checked the comic and gave his approval on the design. Ensuring the quality of meaning from the perspective of the student is more complex (Figure 8). How are students affected by the comic as it tries to convey the academic meaning of the prototext? Will it help them engage in the learning process? I applied Mayer's design principles and had experts review the design, but how the comic affects students remains hypothetical until it is tested on participants.

Figure 7
The sign is the translated work, the object is the object of the work, and the interpretant is the translator sign (Queiroz & Aguiar, 2015)
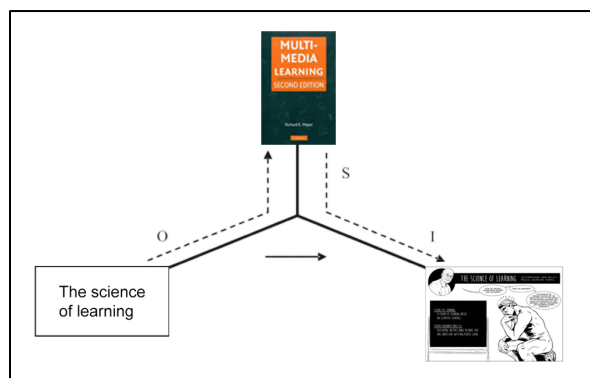
Figure 8
The sign is the semiotic target, the object is the semiotic source, the interpretant is the effect on the interpreter (Queiroz & Aguiar, 2015)
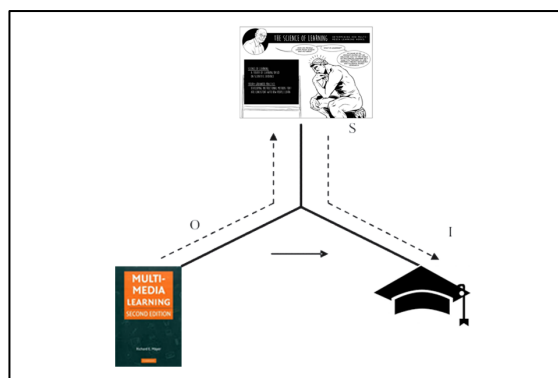

Critical Walkthrough

The following sections will be a critical walk-through of the comic. Pages are discussed in groups of three. I organized the information based on the themes that the thematic analysis of my research journal and expert feedback revealed: 1) visual language, 2) hidden agenda, 3) visuals, 4) navigation, 5) copyright, 6) emotive design and 7) format. When I quote an expert and use a speech bubble combined with a portrait this means it involves a direct quote from their feedback. If the quote is put in the main text, it is a quote from their academic research. Figure 9 shows the different experts and their portrait.

Figure 9
Expert portraits
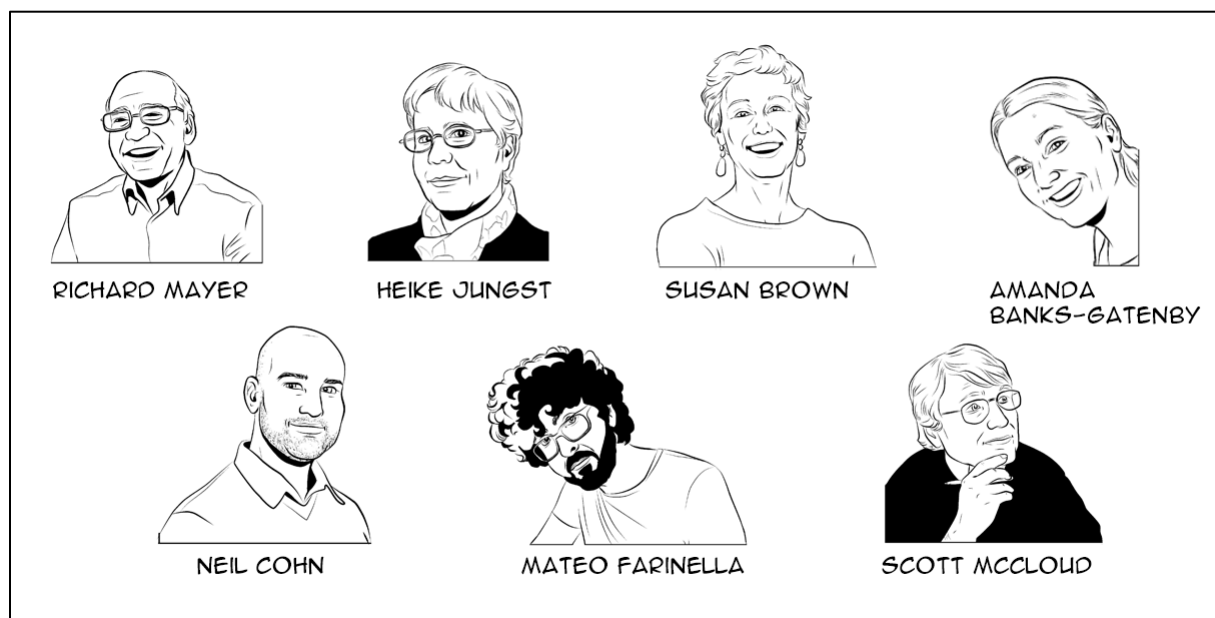
Page 1-3
Visual Language. *Design started with making basic choices. Portrait or landscape? Color or black and white? Portrait is the traditional print-based orientation. I chose landscape so the comic can be viewed on a computer screen without scrolling. I chose black and white because this simplification limits options and requires explicit, well thought-out design decisions. This went over well with the experts.*

Speaking of *Understanding Comics* (1993), I use a high level of realism. McCloud wrote that it is easier to identify with more abstracted characters. He says too much detail makes a person too aware of the messenger to fully receive the message (Figure 10). Realism disassociates. The famous artist Hergé played with this idea by placing his abstracted character in realistic backgrounds (Figure 11). Readers can identify with Tintin and go on a "real" adventure. I tried to make both my characters and setting relatable for students by making it look "real." Was that a mistake? I asked McCloud if my iconic approach would get in the way of the academic message. He expected it would not but had a tip.
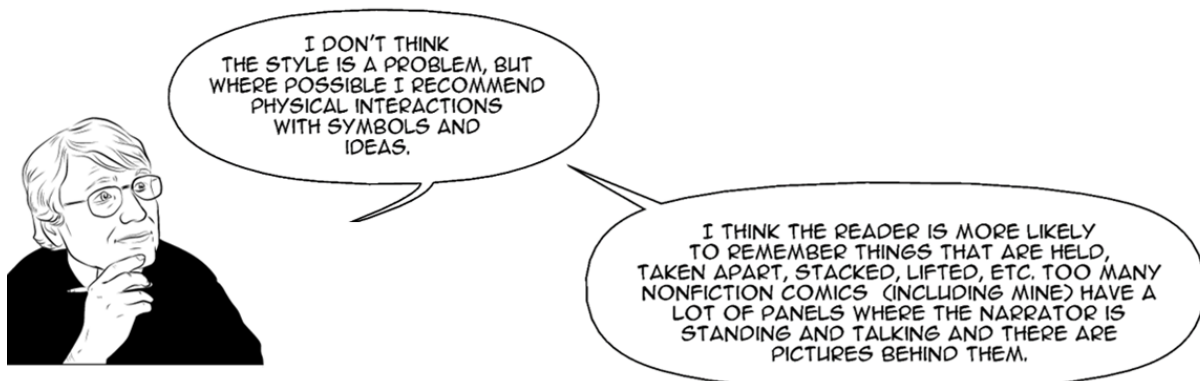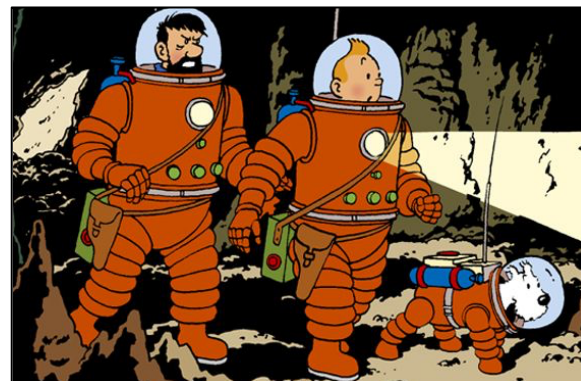
Figure 10
Understanding Comics (McCloud, 1993: p.36)

Figure 11
Explorers on the moon (Hergé, 1954: p.34)

Hidden agenda. All information comics have a hidden agenda. Often, they are about political correctness (Jüngst, 2010, p. 89). My first agenda is proving that the visual language of comics can communicate academic thinking. Figure 12 shows the initial design for page 1. I experimented with the idea of "science minions," little assistants that would help Mayer make his points. I abandoned this because it felt clownish, and I want the comic to be taken seriously. "It is necessary to establish credibility" (Eisner, 199, p. 86). I included Rodin's *Thinker* (1881), Figure 13, a famous piece of art that is linked to thinking. Having this much male presence on page one concerned the experts. Where are the women in science? This taught me to be mindful of political sensibilities, especially on the first page.
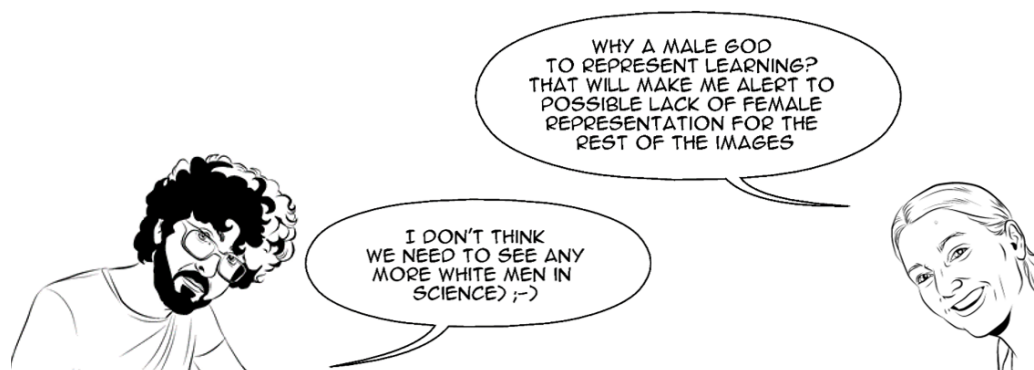
Figure 3
Sketch with science minions
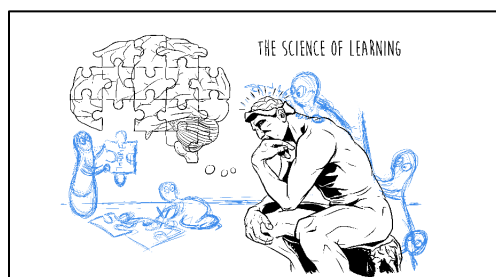
Figure 13
The Thinker (Rodin, 1881)

Visuals. Figure 14 visualizes the idea development for panel 2 on page 2. The prototext describes five kinds of knowledge in 96 words. I managed to delete 91 words by creating icons with labels. When a reader engages with the panel (s)he must decide how the visual is linked to the textual. This image caught the attention of several experts.

Banks-Gatenby liked the fact that the panel requires the reader to actively engage in knowledge comprehension.

Figure 14
Phase 1, 2 and 3 for panel 2, page 2.
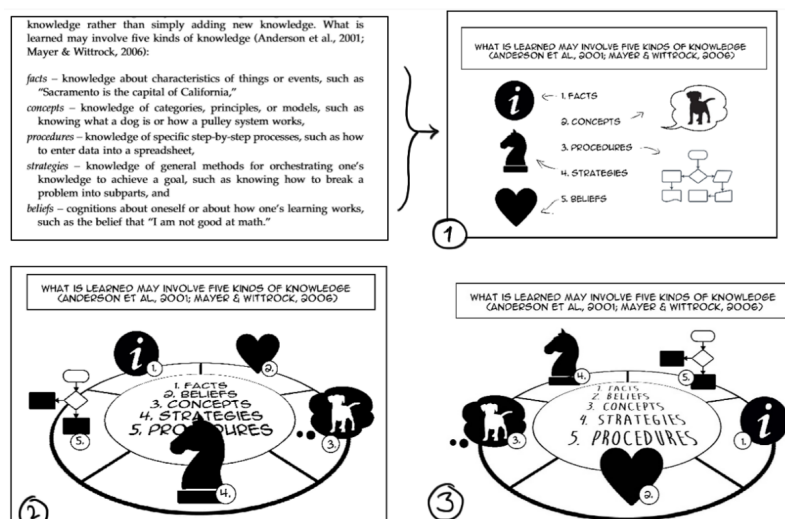
This is in line with Mayer's active processing assumption.

Brown wondered about the relation between prototext and metatext. The icon for concept uses a dog because Mayer used a dog as an example in the prototext ("the Mayer"). This raises the question if the comic is a stand-alone learning tool (yes), or if it serves as an introduction to the academic text.

Jüngst pointed out that "Introduction to…" stories are not considered information comics. I moved away from the prototext for the other icons. Those icons worked for all experts. This taught me that my interpretation of the text is important and that it is okay to deviate from "the Mayer."

Navigation. Cohn approached Figure 14 from his expertise on the structure and cognition of sequential images. He felt that ease of navigation was hindered by not placing the labels directly near the icons. He is correct. I chose aesthetics over function and should not have done this. It confuses instructional design and causes extraneous cognitive processing (Mayer, 2009, p. 79).

Copyright. Comics need clear, sans serif text types. I used Blambot's "Anime Ace" (Figure 15). Blambot provides high quality lettering for publishers like Marvel Comics. They support the independent comic community and offer some of their fonts for free (Blambot Comic Fonts & Lettering, 2020). If my comic were published by a mainstream publisher, I would have to purchase a commercial license.

Part of the comic consists of traced images. Adaptation right applies to literary, dramatic, and musical works, not to artistic expressions. I used images that were labelled as free-to-use and adapt by Creative Commons. Creative Commons is a non-profit organization that helps overcome legal obstacles to the sharing of knowledge and creativity. They provide standardized licenses.
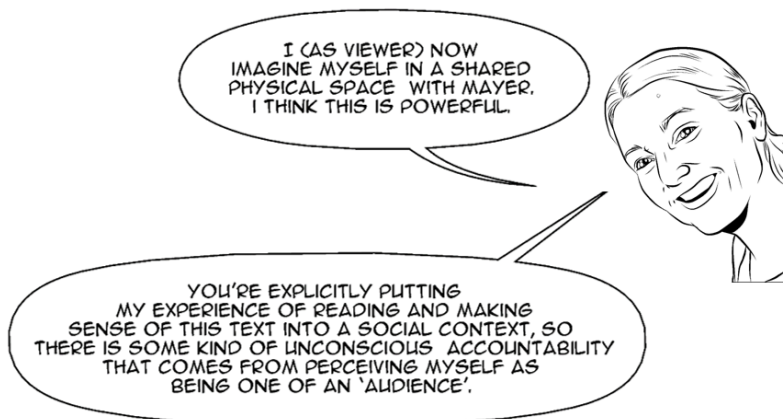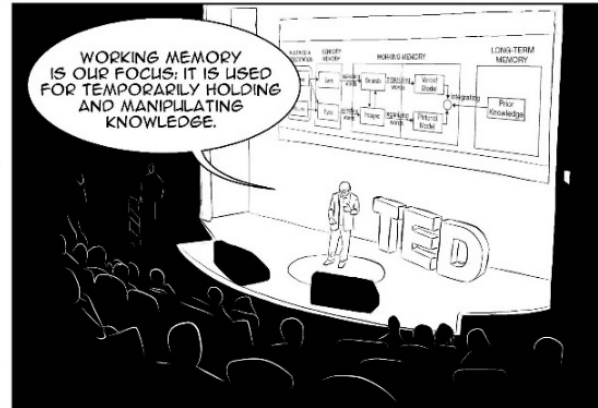
Figure 15
The type font Anime Ace (Blambot, 2001)

Page 4-6

Emotive design. Information comics use emotive elements to motivate the reader and arouse interest in the given text. Packalèn and Odoi (2000) point to the importance of personalizing the comic by using the target group's own surroundings and culture. This makes associations and suggestions more believable. I considered the donor genre — the genre adopted for the information comic, for instance a biography — and settled on a TED Talk. TED is a non-profit organization that posts short, accessible talks online (TED: Ideas Worth Spreading, 2020).
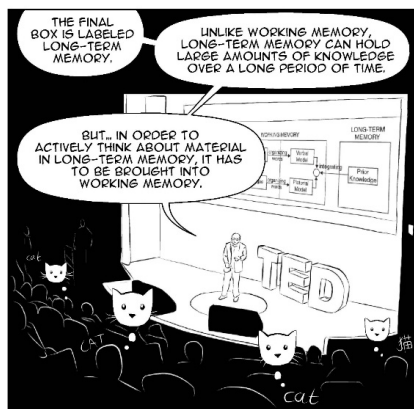
On page 4 the reader discovers (s)he has been part of the audience all along. First the image of the girl is pushed back, indicating a screen. Then an information graphic emerges. After this the logo appears, and you see Mayer standing in a spotlight. Then you see the audience (Figure 16). Audience members function as focalizers, characters that are meant to invite identification from the reader (Jüngst, 2010, p. 76). Focalizers show model behavior, like the well-prepared lady in the audience on page 5. The academic orientated audience from the TED Talk fits nicely with the intended target-group of the learning tool, students in higher education.
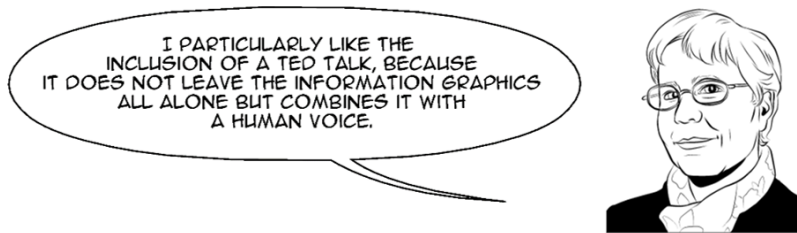
Figure 16
Mayer addresses the audience.

The undeniable expert in the room is the character of Mayer. He is the authority on the subject. His character is designed to physically resemble Mayer, but also to resemble a human being. As such he is credible, but not infallible. On Figure 17 he loses the audience's attention. They are all distracted because the idea that you see a *"cat"* when you hear the word *"cat"* really needs to be explored. I imagine future readers will try this as well, further connecting them to the audience.

Figure 17
The audience is distracted.

Format. I use the TED Talk format as the donor genre for my comic. I expect students are familiar with TED Talks, for instance though TED Ed — the educational part of the platform — or social media. It is not without controversy. In 2010 statistician Taleb called TED a "monstrosity that turns scientists and thinkers into low-level entertainers, like circus performers." It appears comics and TED Talks have something in common. Because of the entertainment factor some critics view comics as an invalid format for information transfer as well (Jüngst, 2010:53; McCloud, 2000). The TED Talk idea was well-received by the experts.

> I PARTICULARLY LIKE THE INCLUSION OF A TED TALK, BECAUSE IT DOES NOT LEAVE THE INFORMATION GRAPHICS ALL ALONE BUT COMBINES IT WITH A HUMAN VOICE.

Mentioning the human voice brings Mayer's design principles to mind. The Voice Principal is about spoken narration in a friendly human voice. Since information comics have no audio, this does not apply. During the design phase the Personalization Principle was used: *People learn better from multimedia presentations when words are in conversational style rather than formal style*. This is a social consideration, intended to increase the learner's motivational commitment.

Visual. I interrupted the TED Talk setting with a more imaginative décor, Figure 18. The academic ideas discussed on this page are abstract, and this gave me the freedom to try a more artistic approach. I used a rounded gutter instead of a straight one to emphasize the difference with the previous pages. Mayer visually brings the reader into his universe (hence the stars) when he explains the underlying assumptions of his cognitive theory for multimedia learning. The two pathways into the brain symbolize dual channels. The barrier gate and funnel symbolize the limits of human cognition. The music notes create a symphony to symbolize the integration of mental representations with another knowledge.

**Figure 18**
Imagination on page 6
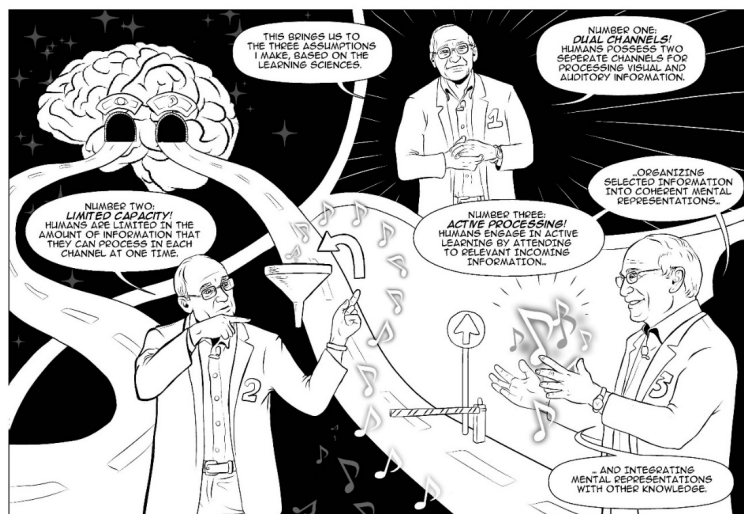
The idea of the two roads to visualize dual coding came quickly. It made sense: two different pathways into the brain. When I searched for dual coding, I learned I was not the first to do this (Figure 19). If this were an art project I would have minded. Originality is valued in art. Visual language is different. The more a visual has been used, the more likely people will understand it.

> PAGE 6 LOOKS GREAT!

Figure 19
*Two examples of similar visualization of dual coding.*
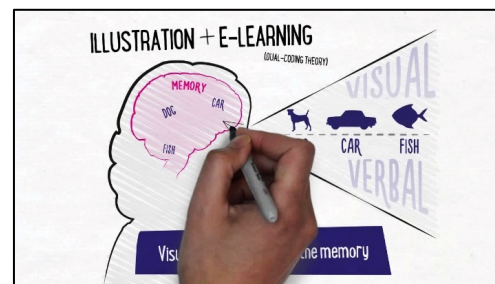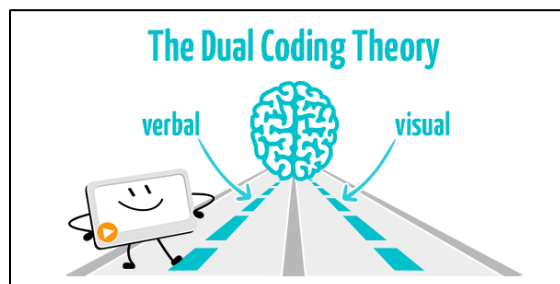
Banks-Gatenby thinks page 6 clarifies the academic content. She also identifies a risk.
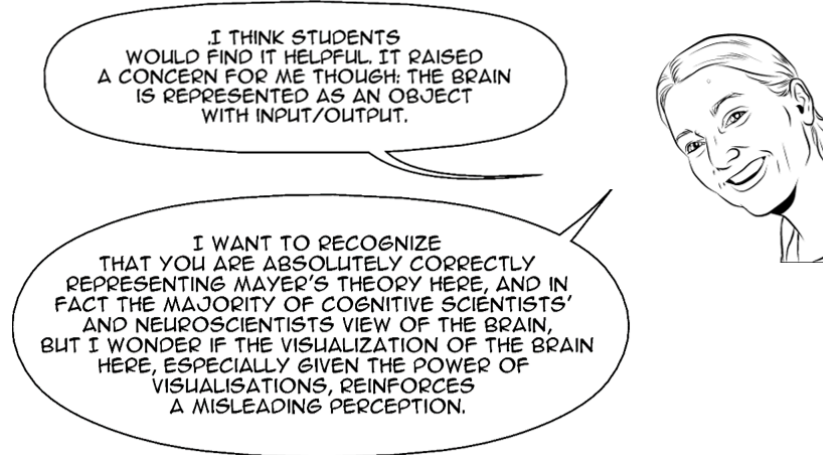
Banks-Gatenby's thinking comes from new research about the human brain. While I do not intend to critique the prototext, she does identify a potential problem: the danger of the problematic metaphor. Metaphors make abstract scientific concepts more relatable to the wider public, but can also distort and oversimplify (Baake, 2003). Comics are an intrinsically metaphoric medium (McCloud, 1993; Sousanis, 2015). The use of metaphors in information comics requires careful consideration.

Navigation. Page 6 is relatively difficult to navigate. The roads leading to the brain transcend the panels which might confuse the reader. The external compositional structure of the panels involves blockage, so the strategy of following the gutter to establish the correct reading order does not work. I tried to minimize extraneous processing by following Mayer's signaling principle: *People learn better when cues that highlight the organization of the essential material are added*. There are pointer words like "number one," "number two," and "number three." The reader may also follow visual clues: the numbers on Mayer's jacket. This is not immediately obvious, so I expected feedback on reading comprehension. Aesthetics and learning are once again at odds. To my surprise the only expert that responded to the issue was Cohn. This may mean that the other experts did not struggle with navigating the page layout, or just did not mind.
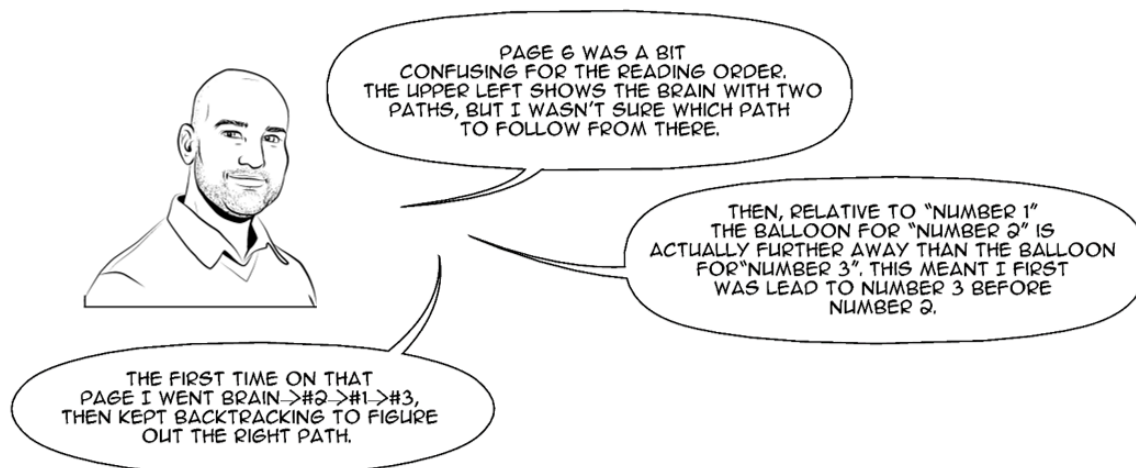
Page 7-9
Format. *Scientific illustrations are often integrated as "pictures in the picture" (Figure 20). The more such an illustration tends toward the abstract, the more likely they will lack the emotive charge that is so typical of comics. Emotive content is never fully eliminated (Jüngst, 2010, p. 175).*

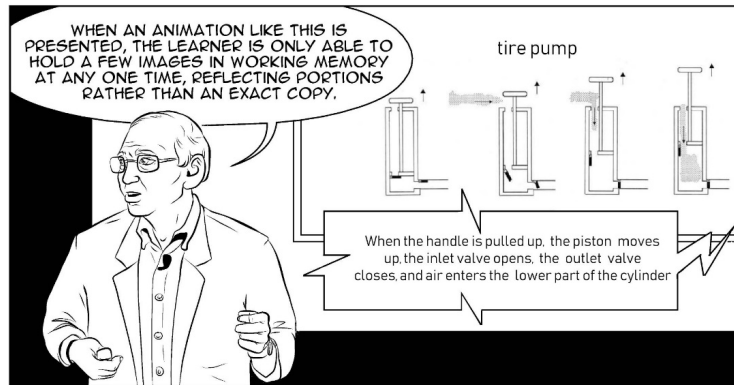**Figure 20**
Integrated illustration

Figure 21
*Popularization (Deschaine, 1998)*

Scientific illustrations can be popularized (Figure 21). I chose not to do this because students' visual literacy should be high enough to decipher diagrams. If that is not the case, this is a good opportunity to train the skill. Because scientific illustrations are not designed to be part of sequential images they may disrupt the navigational flow, risking the reader merely glances at them. I tried to solve this by using repetition. The scientific illustration on Figure 22 appears on pages 4, 5 and 7. Classroom experience is the second reason for repetition. Brown informed me that her students find this particular infographic hard to understand, so I took my time to explain the content. The repetition did not go unnoticed.

Figure 22
Repeated scientific illustration
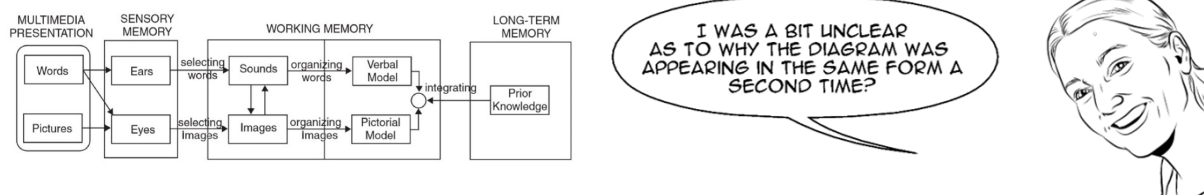
Could this annoy students? Farinella offers a solution.
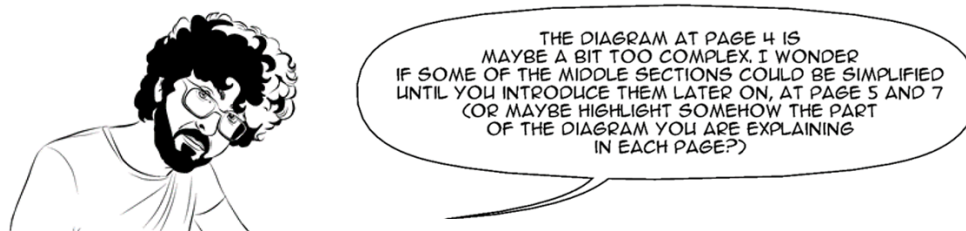
I agree. The information density is too high. Mayer describes a common feature of visual signaling that can be useful in cases like this: graying out. "When a particular component is being described, it is shown in a "magnifying glass" and the rest of the picture is greyed out" (Mayer, 2009, p.112). Graying out the part about working memory would increase clarity on page 4. The whole diagram could be shown on page 5. Page 7 is about the diagram's arrows (selecting, organizing, and integrating). They are placed right through the outer lines of the boxes. Erasing those lines would remove clutter and highlight the arrows.

Visual. How would I visualize "cognition"? Using Google to research a term via the image search function is a good trick to visualize common understanding. Google mostly came up with cogs, so I decided to use that image. The next step was to visualize "selecting," "organizing," and "integrating." I integrated verbal text into the drawing and combined it with symbolic representation (Figure 23). A single puzzle piece represents "selecting," the three connected pieces point to "organizing" and the nearly finished jigsaw on the upper right is my translation of "integrating." A graphic look contrasts nicely with the line drawing of the cogs, so I turned the puzzle into silhouettes. This created a serene, balanced feeling. I like the harmony of page 7. I believe it helps students to focus.

Figure 23
Cogwheels represent the abstract idea of cognition, first idea (left) and final image (right).
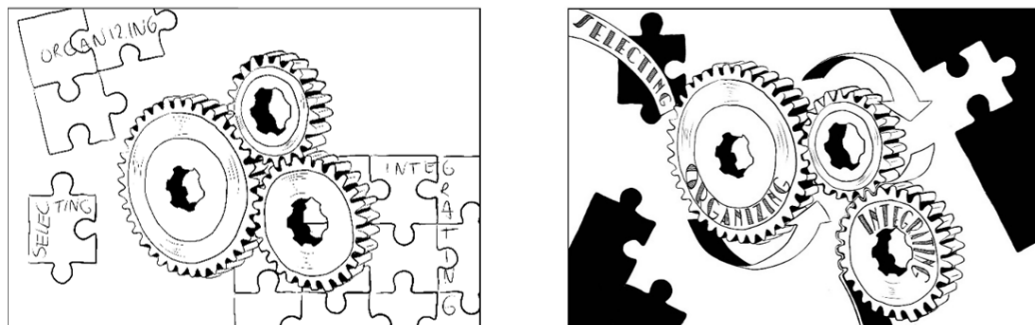
Hidden agenda. Readers approach comics with the expectation to be entertained, but what counts as entertaining? A picture which has an emotive content or emotive quality need not work in an emotive way on all readers (Jüngst, 2010, p. 173). The first panel of page 8, Figure 24, shows icons on their way to either gate "B" or gate "P." "B" stands for Baddeley, "P" for Paivio. Both scientists hang from the narrative caption. I made Dr. Baddeley look a bit goofy and objectified Dr. Paivio, who was as bodybuilder before he became an esteemed academic. In retrospect I regret both jokes. I feel they are not fitting to the academic content and are encouraging the reader to not take the comic seriously.

Figure 24
Page 8 of the comic.
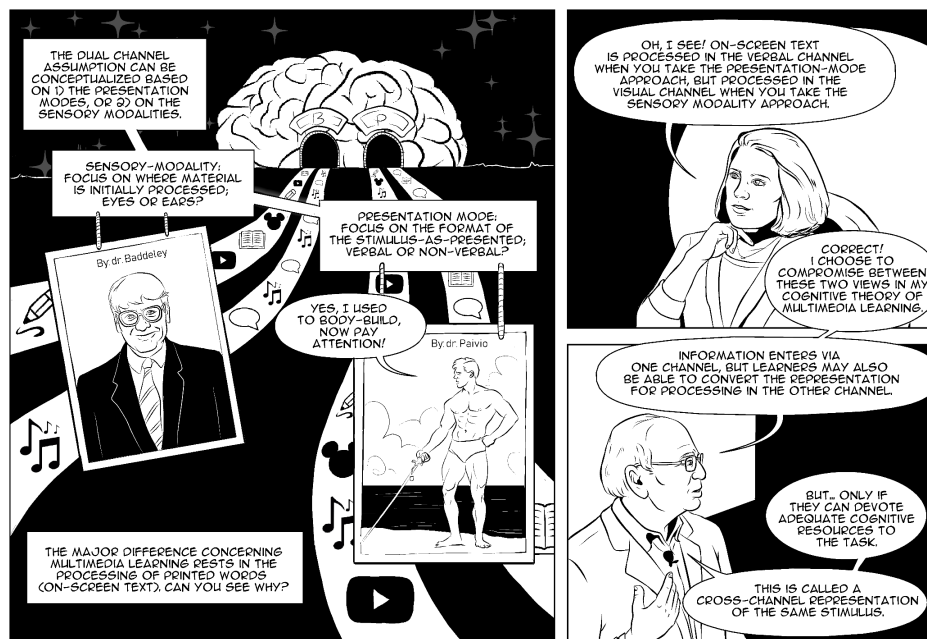
Visual Language. Page 8 has words and visuals competing for space. The experiment was unsuccessful. Mayer's Coherence principle states that *people learn better when extraneous words and pictures are excluded rather than included*. Farinella says it is better to keep things simple as well.

I FIND THE PORTRAIT OF DR. BADDELY AND PAIVIO A BIT DISTRACTING. I UNDERSTAND THE ACADEMIC INSTINCT OF INCLUDING EVERYONE'S BUT IN A COMIC I THINK IT'S ALWAYS BETTER TO SIMPLIFY.

I chose a more sober approach for page 9, Figure 25, and think this works much better.

Figure 25
Page 9
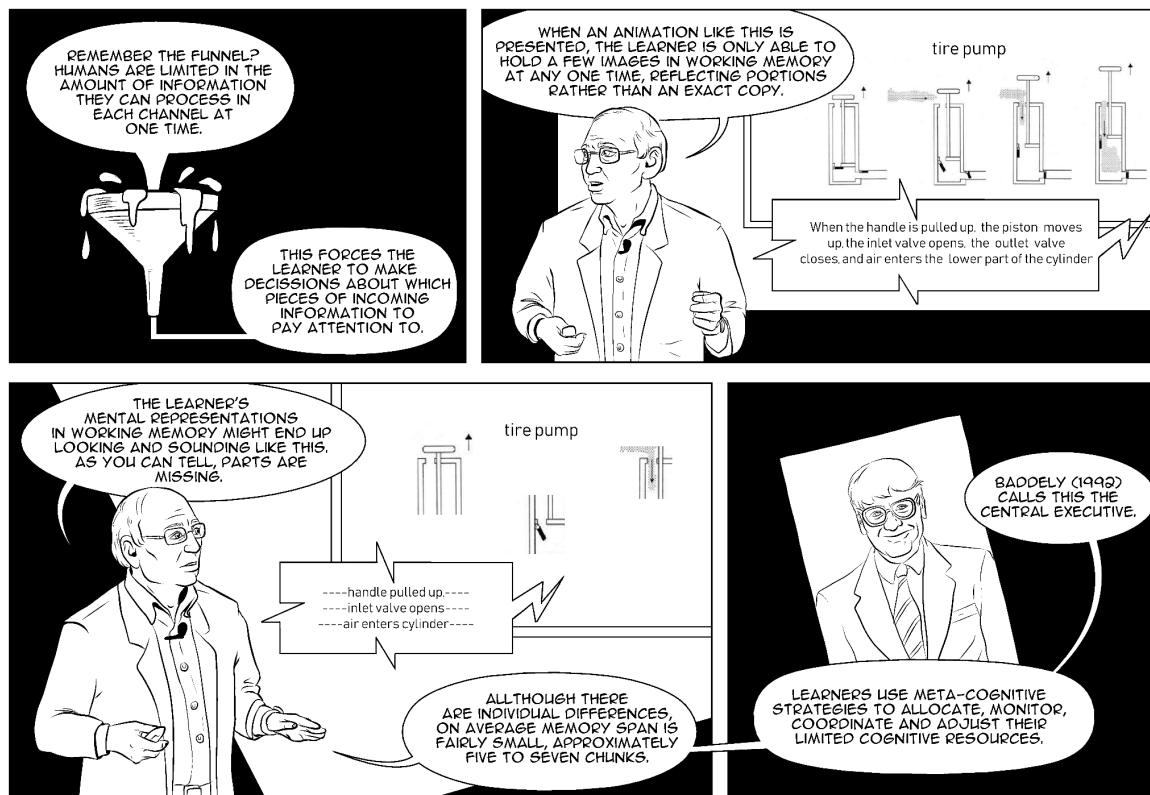
Visuals are a terrific memory aid. Brown describes how she links the image of the funnel — also used on page 6 — to the limited capacity assumption. This demonstrates its mnemonic power.

WHEN I THINK ABOUT LIMITED CAPACITY I THINK ABOUT THE FUNNELING PROCESS. THE PICTORIAL ELEMENT IS COMING IN, INFLUENCING MY THINKING.

After activating prior knowledge, Mayer discusses an experiment he did with a tire pump animation (Mayer & Anderson, 1991). I copied the original visuals into the comic. I needed some way to distinguish between the text that was spoken by Mayer's character and the narrated text that comes from the screen. Luckily there are comic book conventions regarding this. Figure 26 shows a collection of different surface manifestations. The robot/TV/radio carrier fits. I used a different font to strengthen the difference between the narration and spoken words.

Figure 26
*Different types of carriers (Cohn, 2013: p.36)*
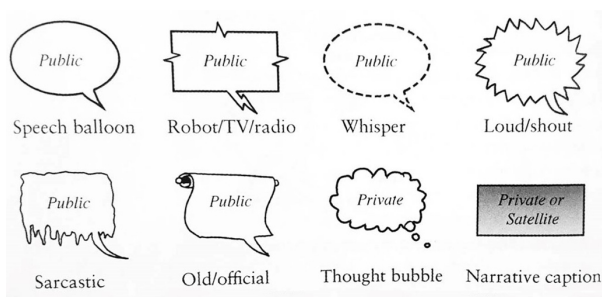
Page 10-12
Visual language. Lines have a hierarchy; thicker lines indicate nearness or suggest larger scale by pushing thinner lines to the background. I used this quality to create depth or emphasize parts of the drawing. The contour of a face for instance is usually more pronounced by the curve of the cheekbones. The effect is subtle but gives the comic a professional appearance. Lines are also important for a sense of style. Everything the artist copies in from other sources (e.g., video stills) should be traced, even line drawings as this brings unity to the page. Figure 27 shows a panel which consists of diverse imagery that is brought together by the line art.

Figure 27
Page 10 of the comic
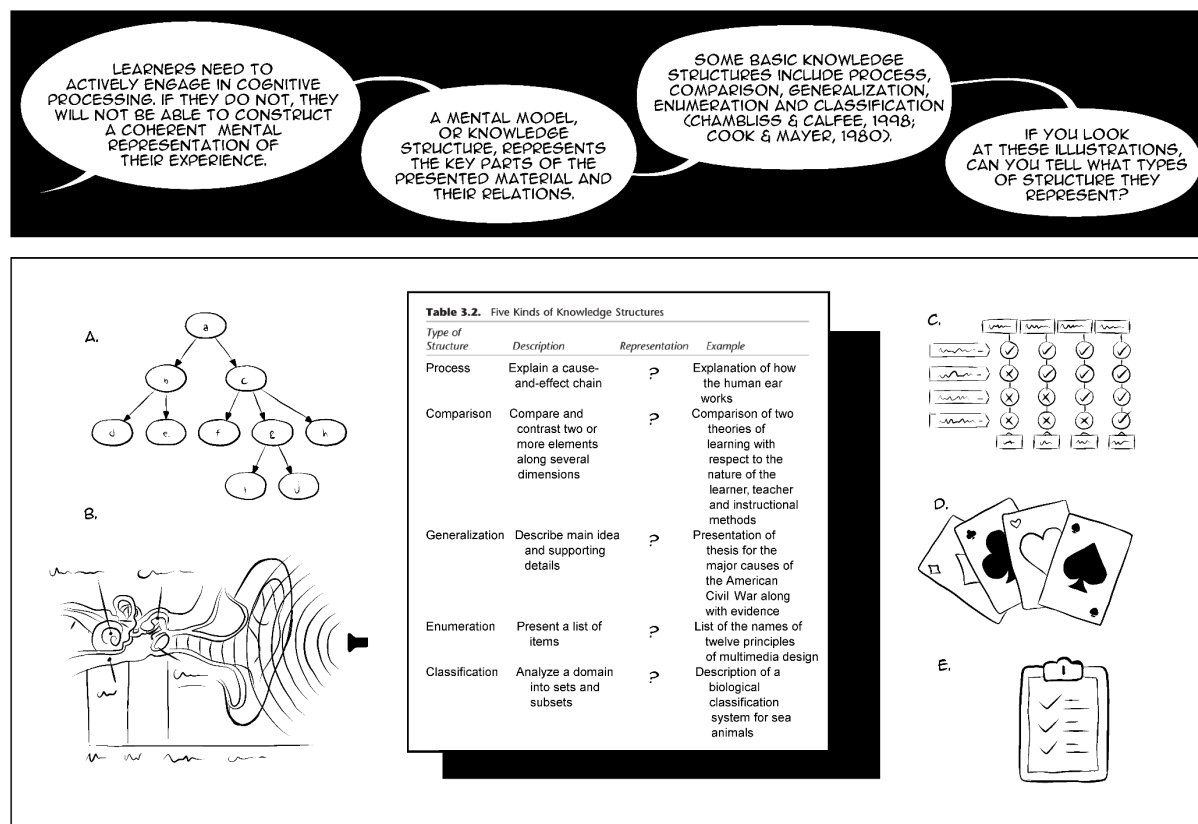
I did not include humans on this page. At least, not as visuals. Readers are invited to engage with the page as learners: can they connect my visualizations of knowledge structures to the description in the infographic? The part of the info graphic that contained the representation is "grayed" out. Page 11 gives learners the solution, so they can check their answers.

THIS IS A NICE ACTIVITY, I ENJOYED IT!

ONE ASPECT OF THIS WHOLE APPROACH THAT SEEMS TO ME TO BE REALLY POWERFUL IS SIMILAR TO POETRY - THE CONNECTIONS AREN'T ALWAYS IMMEDIATELY OBVIOUS AND AREN'T MADE EXPLICIT.

IT THEREFORE TAKES CONSCIOUS WORK TO ATTEND TO THE CONTENT AND UNDERSTAND WHY THE VISUAL REPRESENTATION IS WHAT IT IS, APPROPRIATELY GIVEN MAYER IS SUGGESTING LEARNERS NEED TO ACTIVELY ENGAGE!

This activity invites the reader to think about the different ways you can visualize something. It took Brown around four minutes to connect the visuals. Longer, shorter, skipping the exercise, it is all possible. In comics the reader is the one that decides the pace (Eisner, 1996, p. 50). Mayer's segmenting principle is built into the format. All visuals are their creator's interpretation of the message. I wonder if the activity will make students aware of this.

Format. Did I succeed in creating an information comic? I sought approval from Dr. Jüngst, who literally wrote the book on information comics. She considers the final product an information comic.

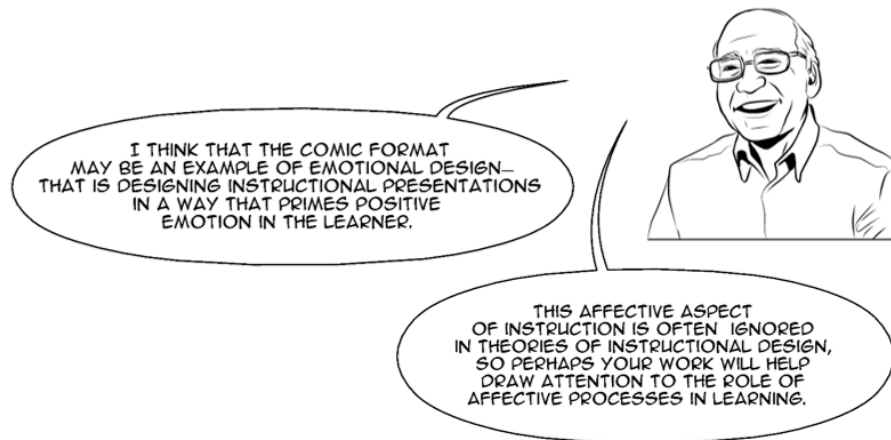THERE IS A DONOR GENRE, NAMELY THE TED TALK.

IT HAS SCIENTIFIC ILLUSTRATIONS WHICH ARE INCLUDED INTO THE TEXT-TYPE FRAME AND WHICH ARE PART OF THE ORIGINAL DONOR GENRE.

THERE ARE FOCALISERS IN THE AUDIENCE THE READERS CAN IDENTIFY WITH; THEY REPRESENT THE TARGET GROUP

IT HAS A BEGINNING AND AN END

The comic reminds Jüngst of the German comic *Die große Transformation* (Figure 28) which also uses talks as the donor genre. She wrote: "*That's a compliment!*" *Die große Transformation* is a visual representation of the 2011 Sustainability report of the German Advisory Council on Global Change. The linework is more loose than mine and there are graytones, but the comic has a high degree of iconicity and covers a serious topic in a scientific tone.

Figure 28
Page 50 of Die große Transformation

Die große Transformation is a digital comic. Jüngst (2010: p.9) talks about the transcendent, not for keeping nature of print-based information comics. These comics are often linked to educational campaigns, only given to the intended target group, and discarded afterwards. Publishing comics online is more sustainable. If the website is maintained, online comics will stay available. Farinella hosts a website that lists science comics.

My final note on "format" is about the varying amounts of pages and information density an information comic can have. *Die große Transformation* has 138 pages and is text dense. Neurocomic (Farinella & Ros, 2013) has 136 pages but is dominated by visuals (Figure 29). My comic has a high information density but consists of only 12 pages. Jüngst (2010, p. 271) says that short texts may seem more attractive to students and are the ideal choice if the comic is meant to be read and discussed in a lesson. I would advise using my comic this way.

Emotive design. Mayer liked the comic.

Figure 29
Page 11 of Neurocomic

Emotion is an aspect of learning. Affective processing and cognitive processing are linked (e.g., Duffy et al., 2018; Loderer et al., 2018). Figure 30 visualizes Mayer's cognitive-affective model of e-learning: "an affective-cognitive model of academic learning which incorporates both affective processing and cognitive processing during learning: the learning episode causes an emotional reaction in the learner that affects cognitive processing during learning and leads to a learning outcome." Mayer wrote that my comic could be an example of emotional design.

Figure 30
A cognitive-affective model of e-learning (Mayer, 2020)

Jüngst mentions emotion throughout her book. In the introduction of *Information comics* (2010, p. 4) she wrote:

*"*The basic assumption underlying this study is that the comics format makes more extensive use of emotive elements than other formats.*"*

When I asked her about the design aspect of comics, she agreed with Mayer.

Reflections

The information comic uses 70% less verbal text to communicate meaning than the original book. The prototext consists of 4203 words, two figures, and two tables. The metatext consist of 1279 words, one figure, and one table. Table 2 compares the verbal text of the prototext with the verbal text of the metatext. Stating that visuals took on two-third of the subject matter is too simplistic because the visual language of comics depends on intersemiotics. Text is needed to convey meaning, just in smaller amounts. This may benefit learners with low verbal literacy skills or dyslexia. Images provide context to the words that go with it. This gives the learner a guide for processing information.

Table 2
Corresponding pages, wordcount and percentual difference of metatext and prototext.

Page metatext	Page prototext	Wordcount prototext	Word count metatext	%
1	58/59	390	71	18
2	59/60	243	91	37
3	60/61	349	126	36
4	61/62	260	106	41
5	62	513	142	28
6	62/63	21	81	386
7	62/63	287	75	26
8	64-66	686	161	23
9	66/67	615	166	27
10	67-69	461	76	16
11	69/70	344	93	27
12	70	34	91	268

Guidelines for design. There are things to consider before committing to the design process. It is important to realize that creating visuals is a time-consuming endeavor and the researcher must be visually literate to be able to do it. Researchers not only need to understand and use images, but

they also must create them as well. The researcher also needs to accept that creating new meaning cannot be avoided and that emotive elements will become part of the final product. It helps if the researcher enjoys working with comics.

In accordance with the lessons learned during the design of the comic I propose 12 guidelines for (re)creating academic information in the visual language of comics:

1. Familiarize yourself with the academic content.
2. Solve potential copyright issues.
3. Match the donor genre and narrative to your target audience.
4. Consider intentional and unintentional hidden agendas.
5. Approach experts for feedback.
6. Put content first and aesthetics second.
7. Keep it simple.
8. Employ emotion to motivate and connect your readers.
9. Always consider the implication of visual metaphors.
10. Use cliches, you are not creating autonomous art.
11. Carefully guide the reader's gaze.
12. Check your work with relevant proven scientific principles, like Mayer's multimedia design principles (2004, 2009).

Conclusion

This study revolves around the idea that using the visual language of comics to communicate scholarly knowledge is possible and benefits learners in higher education. I transformed the written academic prose of pages 58-70 of Mayer's *Multimedia Learning* (2009) into the visual narrative of a digital information comic with support from expert informants. The main finding of the study is that it is possible to create an information comic that communicates academic ideas, provided that the researcher has a high level of visual literacy, accepts that intersemiotic translation always leads to new meaning, accepts that emotion will become part of the final product, and accepts that it takes considerable time to create the imagery. These factors may be part of the reason why even scholarly knowledge around visual literacy is mostly communicated through verbal language.

As expected, the comic never reached the purely pictorial. Text is needed to guide the readers understanding but its volume can be reduced significantly. The metatext needed 68% fewer words than the prototext to communicate meaning, including the words that had to be added to make the comic function as a learning tool.

Emotion is a major factor in the comic format. The role of emotion in instructional design is currently gaining attention. This is a promising line of further investigation. Testing the comic on students may help to draw attention to the role of affective processes in learning and might contribute to an affective-cognitive model of academic learning.

Based on experience and expert feedback the researcher identifies 12 possible steps for the design of information comics. All guidelines are suggestions that could be starting points for further research. It is important to continue research into information comics since information comics show great potential for learning because a) Comics puts knowledge transfer in a popular format, b) Comics tap into affective processing, c) Comics use both verbal and visual language, d) Comics are self- paced, e) Reading comics increases visual literacy, and f) The restricted space for verbal text may serve the needs of dyslexic students and students with low verbal literacy skills.

The main limitation of this study is that the effectiveness of the comic as a learning tool is purely hypothetical. Testing may reveal that it affects students differently than theorized. A limitation of the comic is that the recognizable features from the present-day world might outdate the comic in the future, making it less effective as a learning tool. That being said, testing the comic, like creating the comic, sounds like a fun way to learn!

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Appendices

Appendix I: Mayer's design principles for effective multimedia instruction

Table 1
Principles for reducing extraneous processing.

Principles for reducing extraneous processing	
Coherence principle	People learn better when extraneous words, pictures, and sounds are excluded rather than included.
Signaling principle	People learn better when cues that highlight the organization of the essential material are added.
Redundancy principle	People learn better from graphics and narration than from graphics, narration, and on-screen text
Spatial contiguity principle	People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
Temporal contiguity principle	People learn better when corresponding words and pictures are presented simultaneously rather than successively.

Table 2
Principles for managing essential processing.

Principles for managing essential processing	
Segmenting principle	People learn better when a multimedia lesson is presented in user-paced segments rather than as a continuous unit.
Pre-training principle	People learn better from a multimedia lesson when they know the names and characteristics of the main concepts
Modality principle	People learn better from graphics and narration than from animation and on-screen text.

Table 3
Principles for fostering generative processing.

Principles for fostering generative processing	
Multimedia principle	People learn better from words and pictures than from words alone.
Personalization principle	People learn better from multimedia lessons when words are in conversational style rather than formal style.
Voice principle	People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
Image principle	People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

Appendix II: The Comic
The following pages show the comic in the intended order, 1-12, and in the intended orientation, landscape, but slightly smaller than the intended size, A4.
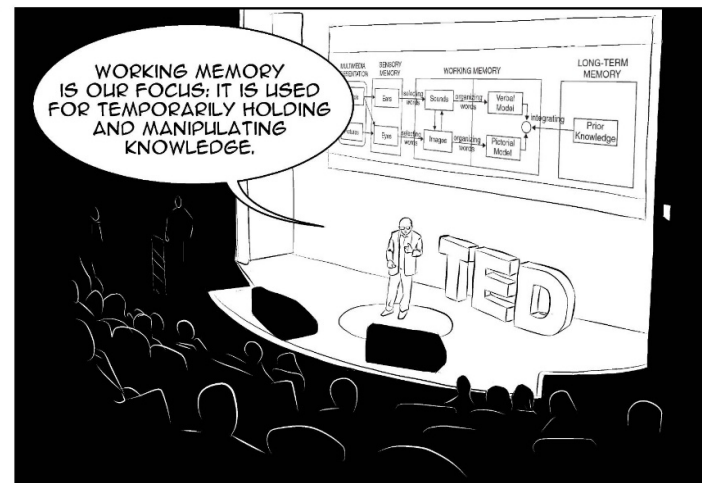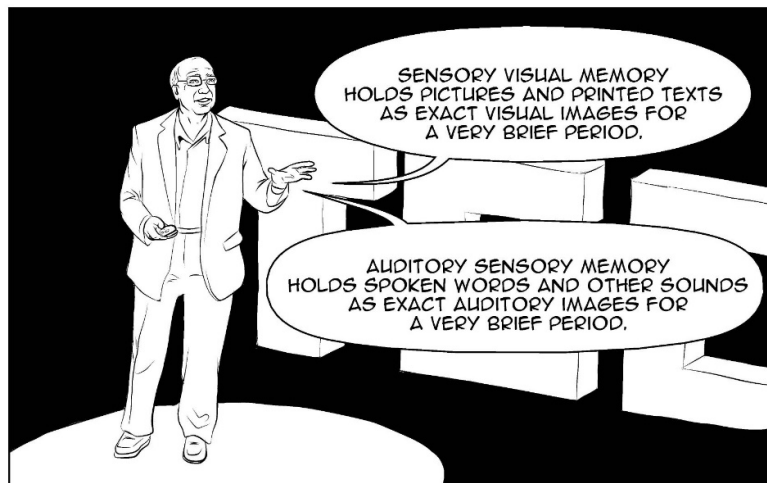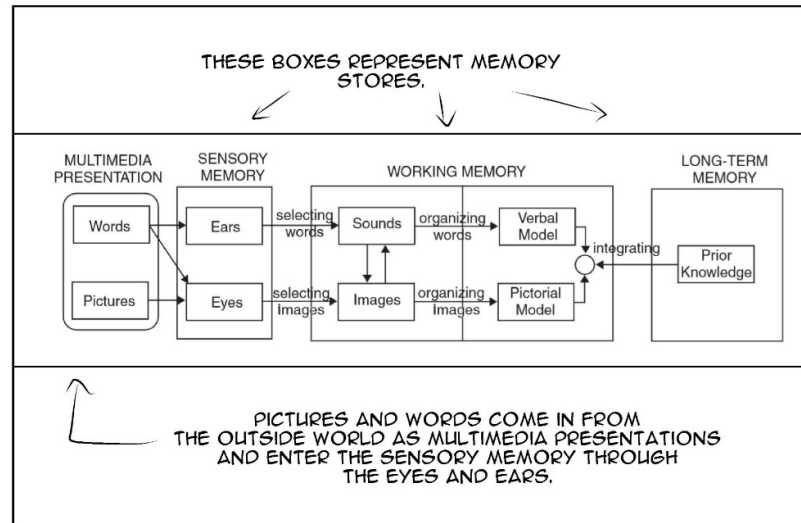
Page 1
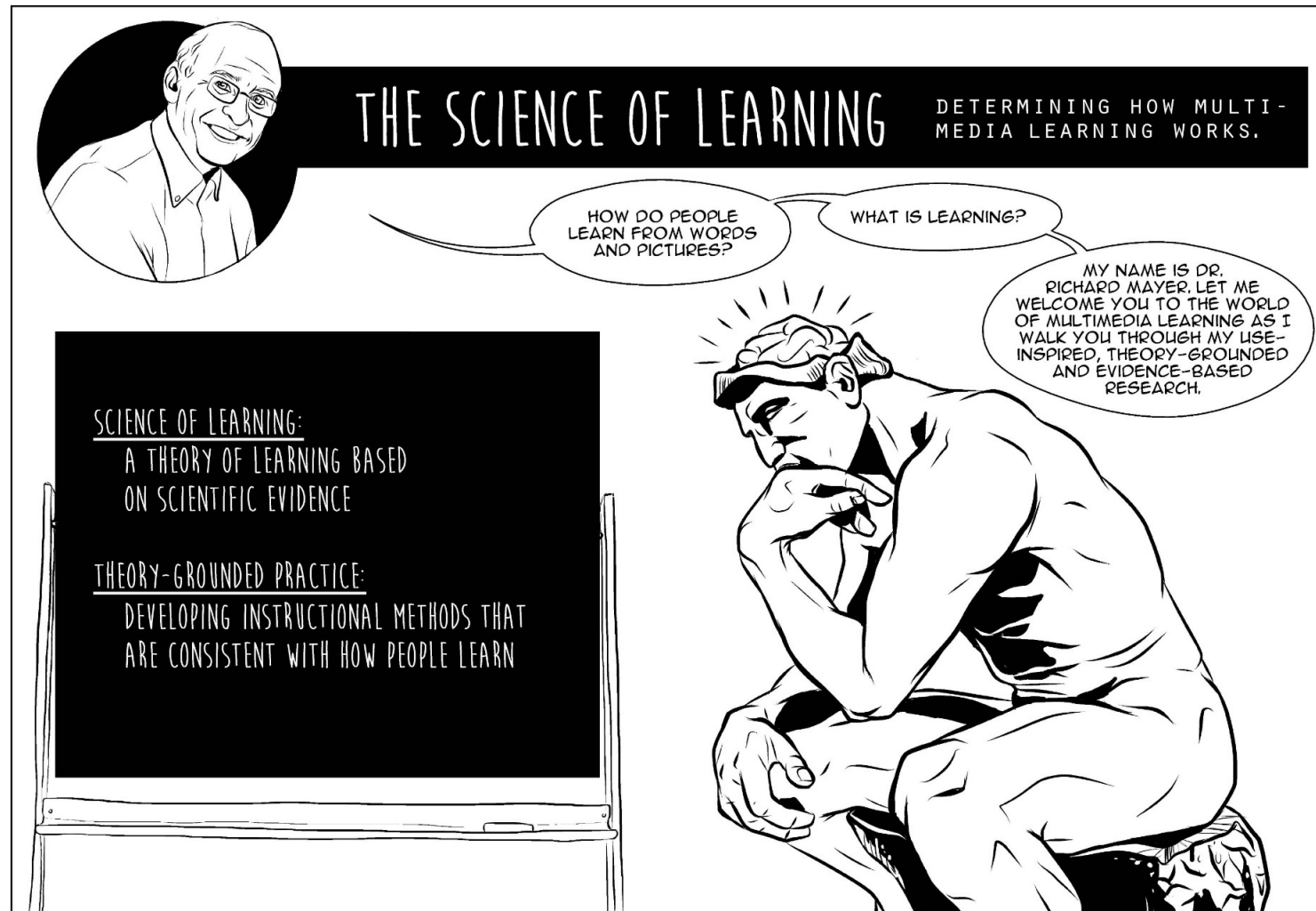
Page 2

Page 3

Page 4

Page 5

Page 6

Page 7

Page 8

Page 9

Page 10

LEARNERS NEED TO ACTIVELY ENGAGE IN COGNITIVE PROCESSING. IF THEY DO NOT, THEY WILL NOT BE ABLE TO CONSTRUCT A COHERENT MENTAL REPRESENTATION OF THEIR EXPERIENCE.

A MENTAL MODEL, OR KNOWLEDGE STRUCTURE, REPRESENTS THE KEY PARTS OF THE PRESENTED MATERIAL AND THEIR RELATIONS.

SOME BASIC KNOWLEDGE STRUCTURES INCLUDE PROCESS, COMPARISON, GENERALIZATION, ENUMERATION AND CLASSIFICATION (CHAMBLISS & CALFEE, 1998; COOK & MAYER, 1980).

IF YOU LOOK AT THESE ILLUSTRATIONS, CAN YOU TELL WHAT TYPES OF STRUCTURE THEY REPRESENT?

A.

B.

C.

D.

E.

Table 3.2. Five Kinds of Knowledge Structures

Type of Structure	Description	Representation	Example
Process	Explain a cause-and-effect chain	?	Explanation of how the human ear works
Comparison	Compare and contrast two or more elements along several dimensions	?	Comparison of two theories of learning with respect to the nature of the learner, teacher and instructional methods
Generalization	Describe main idea and supporting details	?	Presentation of thesis for the major causes of the American Civil War along with evidence
Enumeration	Present a list of items	?	List of the names of twelve principles of multimedia design
Classification	Analyze a domain into sets and subsets	?	Description of a biological classification system for sea animals

Page 11

Page 12