Is this the real life? Connecting mathematics across cultures

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Abstract. Internet memes are hilarious virtual objects widely created and shared by young people in social media, with the purpose of gaining social endorsement by showing wittiness. Mathematical Internet memes are a mathematically themed variation of memes that stemmed spontaneously on the Internet. In this study we test these as means to engage students, connecting school mathematics to young people everyday culture. We present here a teaching experiment carried out in a 10th-grade class group, who created mathematical memes on a given subject and reacted to similarly-themed memes produced by the authors. We describe this exchange as an example of boundary crossing, involving two communities – students and teachers - that fruitfully traded knowledge across the increasingly permeable boundary between young people popular culture and institutional scholastic culture.

Résumé. Les memes d’Internet sont des objets virtuels hilarants largement créés et partagés par les jeunes dans les médias sociaux, dans le but d’obtenir un soutien social en montrant de l’esprit. Les memes mathématiques d’Internet sont une variante mathématique de memes issus spontanément dans l'Internet. Dans cette étude, nous les testons comme moyen d'impliquer les étudiants, en reliant les mathématiques scolaires à la culture quotidienne des jeunes. Nous présentons ici une expérience pédagogique réalisée dans un groupe d'élèves de 10e année, qui a créé des memes mathématiques sur un sujet donné et réagi à des memes sur un sujet pareil produits par les auteurs. Nous décrivons cet échange comme un exemple de boundary crossing, impliquant deux communautés - des étudiants et des enseignants - qui ont échangé des connaissances de manière fructueuse à travers la frontière de plus en plus perméable entre la culture populaire des jeunes et la culture scolaire institutionnelle.

Keywords: Internet memes; popular culture; virtual artefact; boundary object; boundary crossing

Introduction

Successful connections are established when the exchange takes place in both directions. Thus, to build effective links between school and real life, moving mathematics out of school and plunging it into reality (as in real-world problems), is only half of the answer. To search for the bond in the opposite direction, we think that a first step is taken by looking into what young people acknowledge as their *real* world. We may end up surprised realising that a significant part of teens “real life” is, in fact, virtual.

According to two recent surveys on American teens’ familiarity and experiences with technology and social media, conducted in the Spring and Autumn of 2018 by the Pew Research Center, “fully 95% of teens have access to a smartphone, and 45% say they are online 'almost constantly” (Figure 1a) and “majorities of teens say social media helps peers talk to a diverse group of people, support causes” (Figure 1b). Interviewed teens (ages 13-17) declared that social media had a positive impact on their lives "because a lot of things created or made can spread joy." (boy, age 17), "[social media] allow us to communicate freely and see what everyone else is doing. [It] gives us a voice that can reach many people." (boy, age 15) and "it has given many kids my age an outlet to express their opinions and emotions, and connect with people who feel the same way." (girl, age 15). (Pew Research Centre, Spring 2018 Survey)

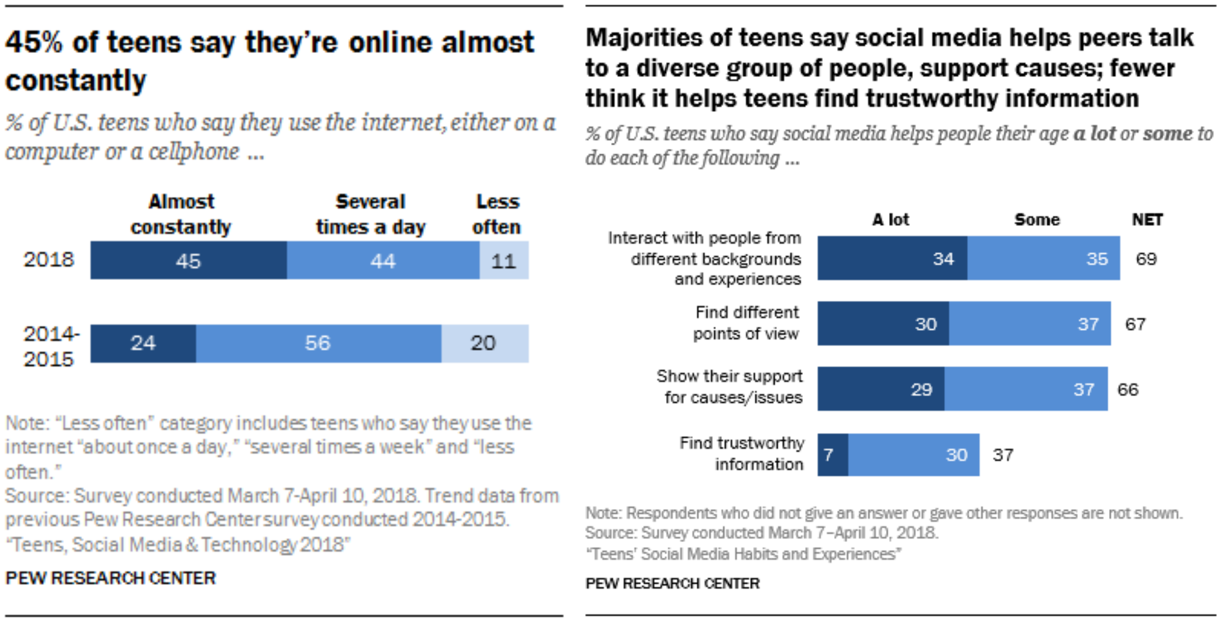

Figure 1a 1b: Pew Research Center findings about teens social media use.

Our aim is to show that the sought-after *everyday life to school life* connection can be initiated by taking something representative of young people's digital habitat and plunging it into the school environment. With their 100 million web occurrences (source: Instagram, Sep 2019), Internet memes could be the right digital artefact to establish this connection.

Memes are humorous virtual objects, widely created and shared by young people in social media, with the purpose of showing wittiness to gain social endorsement. According to Shifman (2014, p.15), memes "reflect deep social and cultural structures" and "epitomize the very essence of the so-called Web 2.0 era". What makes us think they might be our missing link is that, besides being funny and relatable, they have already been spontaneously used to share mathematics knowledge. In fact, social media abounds with mathematically themed groups acting as communities of practice, where knowledge is shared in a process of collective learning (Wenger, 1998).

In Figure 2a we see an example of a mathematical meme shared within the Italian Facebook Group "L'Agorà del Superuovo", paired with the explanation of its mathematical content made by the author himself (2b) and a mathematically improved version suggested by another user (2c).

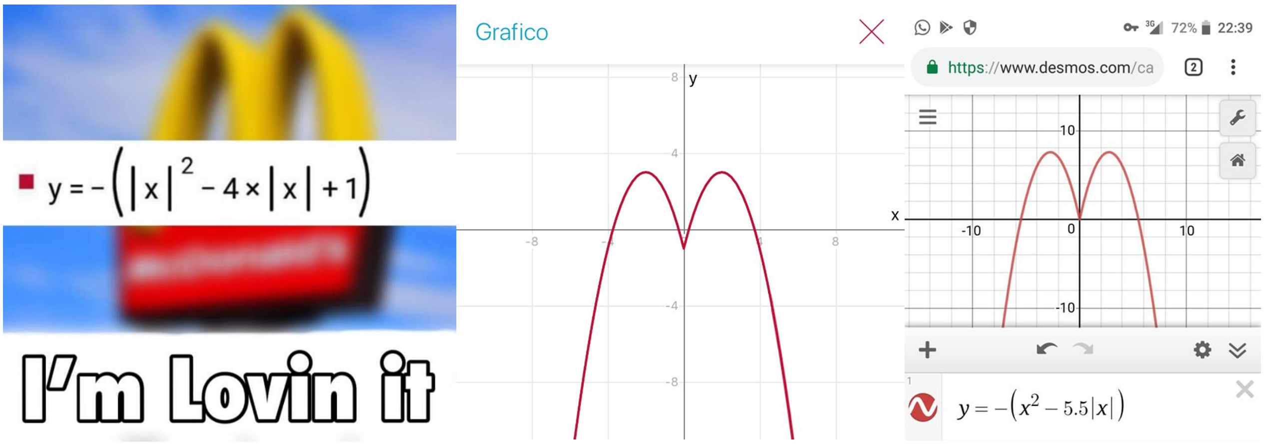

Figure 2a 2b 2c: Mathematics knowledge sharing on social media.

Meanings of Internet Memes

Like jazz variations of classic standards, memes change and evolve in the hands of network users, who personalize and reinterpret them to create humorous snippets, while preserving their recognisability.

They are densely layered objects: to unpack their message, in a previous study we have identified a **triple-s construct** of the partial meanings necessary to grasp the full meaning of a meme (Bini & Robutti, 2019).

Figure 3a 3b 3c: Partial meanings of internet memes.

1. The first partial meaning is **structural**, and lies in its being a meme, namely to have a specific and shared structure and graphics (font, colour, text position, Figure 3a).
2. The second partial meaning is **social**, and lies in the shared conventions of viral images, compositional setups and syntaxes. (Figure 3b, in How to use memes from the website 9gag.com]).
3. The third partial meaning is **specialised**, and lies in images, symbols or text referring to a specific topicin our case mathematical, to be framed within a "sphere of practice", adhering to a common set of rules, where "mathematical meanings are constructed" (Kilpatrick et al., 2005, p.10). [Figure 3c, from the website www.quickmeme.com].

Although in an informal, pop-culture based way, creating a meme on a specific topic implies finding the right match between humour and subject knowledge. For this reason, we believe that memes have some interesting educational potential, that remains almost unexplored to the present day. In fact, besides our previous works (Bini & Robutti, 2019), only a limited number of studies about memes can be found in general education research (Knobel & Lankshear, 2007, Romero &

Bobkina, 2017, Wells, 2018) and in mathematics education research (Benoit, 2018).

Theoretical Framework

Making connections it's all about crossing boundaries, therefore we framed our study within the theoretical frameworks of boundary objects (Star & Griesemer, 1989, Star, 2010) and boundary crossing (Akkerman and Bakker, 2011). We interpret mathematical memes as boundary objects at the same time "both plastic enough to adapt to local needs [...], yet robust enough to maintain a common identity across sites" (Star & Griesemer, 1989, p. 393). They are "artefacts doing the crossing by fulfilling a bridging function" between social media and school mathematics, whose "intersections of cultural practices open up third spaces that allow negotiation of meaning and hybridity" that "carry potential for learning" (Akkerman & Bakker, 2011, pp.133-135). Akkerman and Bakker identified four learning mechanisms activated by interacting with boundary objects: identification, coordination, reflection, and transformation.

Following a recent study applying the boundary crossing framework in mathematics education, we focused on the learning mechanism of transformation, the one that "more than the other learning mechanisms, [...] leads to profound changes in practices" (Robutti et al, expected publication date November 2019, p.3). In particular, we looked for some of the steps Akkerman and Bakker unfolded transformation into: confrontation (taking place when different communities, encountering at the boundary, compare their practices on the boundary object), hybridization, (when a new hybrid object emerges from the involved actors' collaboration), and crystallization, (when the new object stabilizes as part of the counterparts' acknowledged practices).

The research questions we address in this work can be summarized as follows:

- RQ1 Which characterizations identify a boundary object in this context?
- RQ2 Which learning mechanisms emerges from our observations?
- RQ3 How can school mathematics take into account the culture developed by young people in their everyday lives?

Methodology

The example we present was collected during a teaching experiment conducted with a 10th-grade class group, the first author was present and collaborating with the teacher throughout the activity. After completing the topic of linear systems, students in pairs created memes and recorded connected explanatory videos on that theme in a 3h school-based activity aimed at reviewing and systematizing knowledge on the subject. In the following 2h class, they discussed their memes and reacted to similarly themed ones produced by the first author, in a memetic variation of Arzarello's semiotic game (Arzarello et al., 2009).

Collected data include memes and videos made by the students, videotapes of the creative processes of two selected couples, memes created by the authors, videotaping of the following discussion, and entry and feedback questionnaires. The chosen example is taken from the second part of the experiment (the class discussion), where we think that the interaction between the students' and teachers' communities is more evident.

Data and discussion

In the passage analysed in Table 1, the whole group is involved in a collective discussion, orchestrated by the teacher (indicated with T in the excerpt). The discussion focused on the meme in Figure 4, created by the first author (indicated with R in the excerpt).

Using the previously described triple-s construct, we identify the meme partial meanings as follows:

- Structural meaning: *image macro* consisting of an image with superimposed top and bottom text in the typical white Impact font

- Social meaning: the *Kermit drinking tea* image is conventionally used to make fun at awkward situations [source: Know Your Meme https://knowyourmeme.com]
- Specialized meaning: modelling phone price plans as linear equations, using linear systems as tools for comparing plans

The topic for this meme was chosen among those that were not touched by students' in their meme creation activity but was considered worthy of recalling by both researcher and teacher.

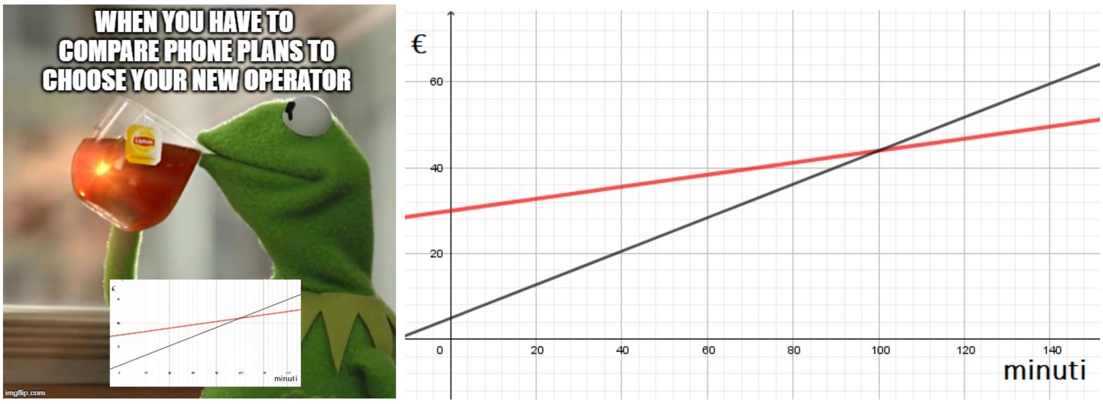

Figure 4a 4b: The meme discussed in Table 1 and a close-up of the inserted cartesian diagram

In the following table we illustrate the connection between excerpts from the group discussion, partial meanings of the meme and Akkerman and Bakker boundary learning mechanisms. All quotations refer to Akkerman and Bakker cited 2011 study on Boundary crossing and boundary objects.

Table 1. Classgroup discussion.

Utterings	Remarks
S1 It's one of those that did not make me laugh T Why didn't it make you laugh? S1 I do not understand the connection between the image and the meme T What does the image tell us? The image is the one you have chosen too S1 Oh yes but my meme was more beautiful [laughter] T What does the image tell us? S1 It conveys serenity, but I do not understand why: what does it have to do with the telephone operator? T Maybe it is not the correct image S2 Maybe it's not really the correct image related to what it wants to express R Maybe	The structural meaning is naturally acknowledged, the discussion starts on the social meaning, the *robust* element that is crossing the boundary. *Confrontation* as "a disruption in the current flow of work" (p. 147).
S3 Yes, it is the correct image […] because phone rates are equations, if you put them on GeoGebra, you can find them immediately when one is cheaper than the other and it's easy and you do not have to lose time thinking S4 And so it's easy T And when does one become cheaper than the other? S3 Before the intersection the blue is cheaper and after the other is cheaper S5 We also did some exercises R Do you remember having solved similar problems? [all	The focus shifts to the specialized meaning, the *adapted* element: students look for it in connection with the social meaning *Hybridization*: "ingredients from different contexts are combined into something new" (p. 148)

students nod] […] T Perhaps you do not see my satisfied expression… how did we solve this? S5 We draw the lines and then we found that when one line was below the other is cheaper than when it was above	

We interpret this meme as an example of a boundary object between the communities of students and teachers, initiating the dialogic learning process analysed in Table 1.

We think that is also worth pointing out that in the opening confrontation episode about the social meaning, only two students are in dialogue with the teacher and the researcher. Once the hybridization takes over and the social and specialized meanings act synergically, students who had remained silent up to that moment intervene with appropriate mathematical arguments, and finally the whole class group acknowledges the mathematical fact that was the primary goal.

Looking at the whole process, we see how, through Akkerman and Bakker's dialogic steps, the different partial meanings complement each other, generating the full meaning that finalizes the boundary crossing and enthuses learning. Sometime after this teaching experiment, we received the following message from the teacher: 'Today we solved a physics problem about uniformly accelerated motion and we ended up with a system... when I asked if we were on the right path, the answer was: sure "two equations, two unknowns", mimicking the meme...'. This suggests that a sort of crystallization as "means of developing new routines or procedures that embody what has been created or learned" (p. 148) has taken place within the two communities.

Conclusion

We think that this example provides important insights into the potentialities of memes as new learning objects, aimed at enriching the teaching and learning of mathematics taking cultural aspects into account. Incorporating memes into didactic practice requires "a shift in our thinking about education" to embrace a "new culture of learning [that] allows us to recognize, harness, and institutionalize" these unconventional resources (Thomas & Seely Brown, 2011, p. 7). We believe this is an important issue for future research, and that memes might be powerful means to create hybrid learning spaces at the boundary between school mathematics and young people's everyday lives.

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