Chapter title: Developing Creative Thinkers with Ahas and Uh-ohs?

Take-away points

- Insight moments as mini-c creative experiences see the beginning of a developmental journey in creative thinking with aha and uh-oh moments playing a part in problem solving that might be applied in the classroom in approaches such as problem-based learning.
- Ideas and knowledge that arrive through insight moments offer the promise of 'added value' by being better remembered; seeing a new understanding unfold from the moment and potentially providing motivation for students to seek out and persevere with future problem solving.
- We could adapt some of the tasks and approaches that research psychologists have used to elicit insight in the lab., so for example word puzzles, tabletop games and magic trick solving. These may be useful to give low-stakes experience that students can then apply and reflect on in solving opportunities afforded in class.

In 2017 Mark Zuckerberg gave the commencement address at Harvard with a focus on creativity and innovation. Tucked within his speech was the line: "The idea of a single eureka moment is a dangerous lie". Now, I am fairly sure Zuckerberg was not claiming to be an academic expert on creativity, nor specifically insight research. Those that are, provided an immediate rebuttal to this idea (see an excellent New York Times article by John Kounios – listed in recommended reading for this chapter). As such, the question of whether eureka exists is not the 'hot topic' of discussion here. Insight moments do exist and as Kounios (2017) highlights have been widely researched over the last century, where they are shown to be sudden and new ideas or understanding accompanied by an Aha or Uh-oh moment (Hill & Kemp, 2018a). So, setting aside this debate, my thoughts drew towards Zuckerberg's audience that day: A group of lauded, highly educated people; the ceremony representing to many the pinnacle of educational attainment. I wondered from the student group, or their professors also listening in, how many had ever really thought about insight or eureka at all? Certainly, to me the most interesting thing was perhaps a misunderstanding or simplification

of what eureka or insight moments are and perhaps a lot of [false] assumptions specifically about their role in creativity. As such, this chapter aims to explore what research tells us (and is continuing explore) about eureka, these famous and infamous creative insight moments of epiphany. It will aim to think specifically about these in the context of learning and education by asking the following:

1. Why are insight moments of interest in the classroom?
2. Why we might be specifically interested in insight moments rather than creativity or problem solving in general?
3. How can we help students to have more insight moments?

Why are insight moments of interest in the classroom?

It is likely that many teachers may also disagree with any discounting of eureka, given they often use such insight moments as indicators of learning in their students (Liljedahl, 2016; Lindström & Gulz, 2008; Weiss & Helskog, 2020). There are various external signals of the internal mental clicks and flashes that students may show, with distinct exclamations (e.g. "Aha – I see"), facial expressions or behaviours. These accompany an inner feeling of Aha, a combination of pleasure, suddenness, surprise and possibly of having overcome an impasse (Danek et al., 2014). Insight is transformative, once thought the creative idea cannot be unthought (Jarman, 2016; Öllinger & Knoblich, 2009). A click of insight not only represents a sudden association of previously unconnected components, but allows all the possibilities of that connection to unfold with relatively little need to verify things (Bowden & Jung-Beeman, 2003; Danek et al., 2014). These moments might often represent a sought-out shift in understanding and even attitude in a student (Liljedahl, 2016; Singh, 2011). If such shifts could be elicited, captured or replicated, perhaps as threshold concepts then there may be a way to arm learners with a prepared mind to experience such moments (Meyer & Land, 2006).

Learning an insight facial expression? There is actually very little research into how insight moments are experienced or develop through childhood.

A useful model in thinking about insight is provided by Kaufman and Beghetto (2009), which separates creativity into four different levels of achievement. This labels eminent creative achievements such as Archimides' archetypal eureka moment as Big-C, but recognises that a lot of creativity does not fit into this category. Most of us will not reach a level of eminence to show Big-C in our lifetime! To be fair to Zuckerberg, I suspect this is kind of the point he was trying to make too: Suggesting that other forms of creativity are more achievable for individuals to aspire to, rather than waiting for a Big-C eureka to hit out of the blue. Accordingly, the other types of creativity they describe, Pro-C, little-c and mini-c may be more pertinent in our consideration of insight moments in this chapter.

In fact, Big-C creativity does not appear from nowhere, rather it builds on knowledge and creativity at these other levels. A nice example of this is the creative endeavour of Vijay Kakkar, who pioneered the use of anticoagulants in post-operative treatment (Plucker, 2019). He was surprised by the unexplained deaths of some of his patients following surgery, which was something that everyone just accepted as 'one of those things'. But Kakkar set about solving this problem, with his solution now estimated to save around 300,000 deaths each year. However, Kakka initially saw this as a bit of a hobby, an aside from his 'day job' as a surgeon that perhaps fits the label of little-c. Although, most think of little-c everyday creativity more along the lines of activities such as crafting, painting etc. Pro-C then, where people professionally engage in creative pursuits might fit better here? Again, other professionals such as designers, artists and perhaps entrepreneurs like Zuckerberg may more readily spring to mind. However, undeniably Kakkar's creativity saw him solving a problem from his professional life, albeit one he was not initially paid for or acknowledged by the wider medical community. His work only moved to Big-C status as the effectiveness of his solution was recognised and adopted, finally seeing his persistence suitably rewarded and eminence recognised.

Here we see a developmental trajectory as creativity progresses from little-c through Pro-C to Big-C. Mini-c then paves the way for this progression. It is creativity that occurs within the individual, whose ideas are novel and useful to them (Plucker et al., 2004). Mini-c insights will often be about something that is already widely known, so not novel using the classifications of Big-C, Pro-C or little-c. But they are new and salient to the individual and as such are seen as examples of creativity. Mini-c insight moments therefore are relatively small-scale, personal epiphanies that occur suddenly, are accompanied by the feeling of emotion (e.g. Aha or Uh-oh) and constitute a moment of learning (Hill & Kemp, 2018a).

These are the insight moments of the classroom, that can form foundations of future creative thinking at the other levels.

But why specifically, insight moments rather than creativity or problem solving in general?

After all, ideas can build and knowledge be assimilated without insight moments, gradually through search type processes (Bowden & Jung-Beeman, 2003). First, information gained through insight sees a memory advantage compared to those where a solution was found through gradual search techniques (Danek et al., 2014; Danek & Wiley, 2020). For the most part it seems that the level of certainty seen when solutions arrive through insight persists to make these ideas better remembered in the future. In addition to occurring as a solution, insight moments can also occur as uh-oh moments; where we become aware of a problem, suddenly and for the first time (Hill & Kemp, 2018a). Models of creativity highlight how problem finding is a key feature in creative thinking [add signpost to this in another chapter]. As we saw earlier, it was Kakkar's identification of the problem, which many had overlooked that then led him to set about solving it. This suggests that insight moments have a role in helping students to identify problems, as well as providing accurate solutions and facilitating the memory of this new knowledge, for example through problem-based learning (Hmelo-Silver, 2004).

A further fascinating answer to this question comes from a suggestion that scientists, STEM professionals like Kakkar are insight-seekers. Maryam Mirzakhani, winner of the Fields Medal[1] outlined her experience of insight moments in mathematics as follows: "The most rewarding part is the "Aha" moment, the excitement of discovery and enjoyment of understanding something new, the feeling of being on top of a hill, and having a clear view" (CMI, 2008, p. 12). Further support for this intriguing idea, comes from research within the cryptic crossword community. One at first might imagine that those engaged in word-play puzzles may come from professions such as writers and other literary-based creative fields. On the contrary, Friedlander and Fine (2018) showed that by far the largest profession represented in the solving community had careers in STEM. Furthermore, a key reason that people engaged in solving was pursuit of the PDM – 'penny dropping moment'. So strong is this community's affiliation with Aha moments, they have developed their own vernacular to describe them, PDMs! Here we see that not only do Pro C scientists employ and seek out

[1] The Fields Medal is seen as the equivalent to a Nobel Prize and is one of the highest forms of acknowledgement for a mathematician.

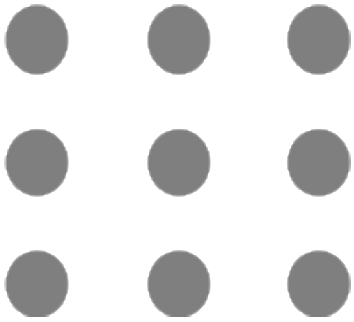
creative problem solving in their work lives, but many seek out further opportunities to experience insight in their choice of hobby.

Insight in the lab.

The range of lab. based tasks that have been shown to elicit insight moments could provide a promising avenue to adapt for classroom activities. These highlight how eureka is not specific to a single domain, so it's not just science and maths! Try out some of these yourself, the answers can be found on page xx

Riddles and puzzles

1. Connect all the dots using only 4 straight lines.



The 9 Dot Problem (Maier, 1930) is a classic insight problem, these riddles or puzzles only give a one-off solving opportunity! Also, as you'll see if you check out the answers, many of these have found their way out of the lab. meaning many of the answers are quite widely known.

Word-based problems

2. What word, when paired with each of the words below results in a compound word or phrase?

river note account

3. What well-known phrase or saying does the following represent?

Right iiiiiiii

The top puzzle is a RAT (no not a small animal), the remote associate test (Bowden & Jung-Beeman, 2003) provides lots of opportunities to solve through insight. These are quite hard, given they were developed for adult participants!

The bottom (No. 3) is a Rebus puzzle (MacGregor & Cunningham, 2008), also called wordies that uses words but also position as their basis. Again, these are developed for adults, but could be adapted for a younger audience.

Match-stick maths

4. Move one stick to make this sum work.

Different puzzles can involve moving different sticks (see solution to this puzzle). Above the use of roman numerals for numbers above three expands the possible puzzle bank (Knoblich et al., 1999).

Connect 4

Adults playing this table-top game have been shown to experience both Ahas and Uh-ohs! (Hill & Kemp, 2018). With simple rules, affordable and easy to clean (plus lots of free online versions) this is ideal classroom use (these are some of my students in a problem-solving class).

Magic tricks

Amory Danek showed that people have insight moments when trying to work out how a magic trick is done (Danek et al., 2014). Have a try yourself by visiting Amory's website: http://www.amorydanek.de/research/

This introduces aspects of drama and performance, as the magician looks to trick their audience!

Story telling

Frank Loeshce developed Dira (Loesche et al., 2018), a computer-based version of the card game Dixit (see https://en.wikipedia.org/wiki/Dixit_(card_game)) He found this reliably produced insight moments. In this game, a story is told based on one of a selection of cards. The insight moments come when players identify which card and why.

Perhaps our insight-seeking scientists are capitalising on the fact that rewarding, Aha moments provide motivation in the future to continue solving attempts when things get tough. Previous experience of successful solving shows the solver that perseverance is ultimately beneficial, with the Aha experience helping to make this moment stand out due to the pleasurable feeling (Gopnik, 2000; Oh et al., 2020). Recent neuroscientific work supports this idea by showing underlying brain processes in insight akin to other rewarding experiences (Becker et al., 2020; Kizilirmak et al., 2019; Oh et al., 2020; Tik et al., 2018). With some popular media provocatively going as far as to claim that "crosswords [are] better than sex!" (Allen, 2018). This suggests that Aha moments are something that might be sought out and reward solvers to stick with their solving efforts in the future. There is an exciting additional possibility then (but as yet without definitive research support) seeing benefits of insight that extend beyond the immediate learning or problem-solving episode. We might use these powerful insight moments to help motivate future problem-solving activities and think about this in contexts such as the classroom or lecture theatre, particularly in terms of mini-c.

So how can we help students to have more insight moments?

In reality it is hard to elicit insight on demand. For example, Peter Liljedahl (2016) set out to elicit classroom insight, building on his work identifying the value of Aha moments in undergraduate mathematics students. However, things were not as straight forward as anticipated, and he found barriers in typical classrooms that seemed to block insight moments. Subsequent exploration suggested the need to first establish 'thinking classrooms' (p. 362) in order to give students tools, such as a prepared mind and willingness to both explore and be comfortable with impasse (and so incubation), that may be central to creative problem solving.

Some of the games and tasks used by insight researchers shown in xxx [check how signpost to this] may be useful tools in a journey towards a thinking classroom. For example, playing games and explicitly reflecting on Aha and Uh-oh experiences may help to open students minds to different ways of solving problems. Moreover, as it is suggested that experiencing insight motivates future problem-solving behaviour, then games could provide low stakes opportunities to generate Aha and Uh-oh moments. However, a word of caution here, currently little work has been done to explore the use of insight tasks beyond the lab. so we do not know if this works and how best this might be applied.

Work that has shown promise in eliciting insight moments in the classroom is outlined by Vandana Singh (2011). She gave her students a NASA or New Scientist article at

the beginning of a topic to read and answer some basic questions about, but crucially links were not made to the upcoming material they were about to study. At the end of the topic, students were then invited to re-read the article, with many visibly experiencing insight moments as they made connections back to their class content. This provided a personal demonstration of changed understanding and highlighted how physics theory could be used in an applied context. In these examples it can be seen that the students initially experienced uncertainty and a feeling of not knowing and impasse that is often uncomfortable. By then returning to the articles and experiencing the consequent Aha moments it enabled them to gain confidence and perhaps be more comfortable with initial uncertainty. Furthermore, explicit discussions of the creative problem-solving process could be incorporated in such tasks to aid students' reflections.

What does this mean for other students who might not have an insight moment?

An encouraging finding here is that it seems that you do not have to have generated the answer yourself in order to experience an Aha moment. Several studies have found that when solutions are given to solvers, who have yet to find the answer or are stuck in their solving attempts, they still often experience an Aha (Kizilirmak et al, 2016; Webb et al., 2019). Therefore, those sharing an answer with their class or a teacher providing feedback of answers might elicit mini-c Aha moments in others and so see benefits via a vicarious Aha. For instance, providing or discussing problems and subsequent solutions could generate some early insight experiences for students and help to motivate future solving attempts. A cautionary note here again is that of course these are lab.-generated findings, which we as yet cannot say for certain operate in the same way in the classroom or in younger age groups.

A further consideration is that some students may not experience insight at all. Linda Ovington (Ovington et al. 2016) found that an intriguing 20% of participants in her large-scale study of adults in Australia reported never having experienced an insight moment. This corroborates some of my own (unpublished) qualitative work conducted before Ovington's work was published. I recruited participants for a diary study to follow their insight experiences over the course of a week, but many reported having none at all. For me this was somewhat of an Uh-oh moment. Was it that they truly had not had insights at all, or had they forgotten to complete their diary? In follow-up interviews they explained to me that despite looking out for these moments they did not experience any and crucially, felt that they never had. Therefore, some caution should be applied in expecting all to experience or benefit from Aha moments until further work is done with this group of people. In fact, it could be

alienating to describe insight moments as-if they are a universally experienced phenomenon, if you are one of this group.

So, to conclude, Alison Gopnik (2000, p. 303), professor of developmental psychology suggests that "it is not that children are little scientists but that scientists are big children". Through a focus on these 'big children', our Pro-C, STEM professionals, we have identified the part mini-c insights may play when working with children. As seen in the lab.-based insight tasks however, insight moments occur across domains, so are not exclusive to STEM subjects. Not only can Ahas and Uh-ohs play important roles in classroom problem solving and topic-based learning but might also provide foundational experiences in the development of creative thinkers. By exposing children to, and getting them to reflect on experiences of insight moments we might look to help grow motivated and resilient problem solvers. So, finally and in direct response to Zuckerberg, "Eureka moments aren't a dangerous lie, but they are real complicated!"

Recommendations for Further Reading

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Answers to insight puzzles above:

1. 9 dot problem: see milk carton →

2. RAT problem: River
3. Rebus problem: 'Right before the eyes'
4. Matchstick maths: