# How to train the deliberate use of intuition

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## Abstract

We aim to investigate how to professionally train our skill at using intuition deliberately because prior research has shown that intuition has the potential to outperform the analytical mind, especially in complex and uncertain situations that will become only more frequent in the years to come. Teaching people to learn how to use intuition can be particularly decisive because it represents a crucial soft skill for the next generation of critical and creative thinkers. By applying advanced bibliometric analysis techniques in this mapping study, we systematically explore and visualize intuition research to highlight potential methods to train the skill of deliberately using intuition in the classroom. Our Web of Science data set comprises 7,680 peer reviewed documents with 253,986 references published by 166,649 authors through the end of 2021. Despite these high numbers, intuition is an underexplored scientific field characterized by methodological challenges, some of which are due to its unconscious nature. Our study offers first insights into research that can enhance the use of intuition. Our main goal is inspiring future research to help reveal intuition's unexploited educational potential, which can then stimulate new teaching initiatives.

## Introduction

Tomorrow's generations will have to cope with more complex issues than we face today. According to the 2021–2024 Strategy and Development Plan of the Swiss Federal Institute of Technology Zurich (German: Eidgenössische Technische Hochschule Zürich, ETH Zürich), we are responsible for paving the way for today's young people to cope most effectively with the complex world of tomorrow. These critical and creative thinkers will have to make significant contributions to the common good and help preserve societal well-being, natural resources and the environment. This ambitious but vital goal means that skills like analysing and developing new solutions and making decisions using creative thinking will be essential. This approach supports with ETH's objective of promoting the acquisition of soft skills like entrepreneurial thinking and intuitive decision-making, social skills, leadership abilities, computational competencies and the ability to analyse complex issues.

To maximize the skills necessary for tomorrow, we must use both intuitive and analytical mindsets. Intuition represents the skill of using subconscious information in making conscious decisions (Lufityanto et al., 2016). We have many established tools to improve our analytical skills but scarcely any to train people – professionally, formally and effectively – to use intuition deliberately. Researchers studying cognitive thinking styles have so far spent much of their energy on controversial debates (Leach & Weick, 2018; Lurquin & Miyake, 2017; Wang et al., 2017) over whether intuition leads to errors (Kahneman, 2003; Tversky & Kahneman, 1973, 1974) or to superior results (Dane et al., 2011; Gigerenzer & Gaissmaier, 2011; Levitt, 2021; Waroquier et al., 2010).

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Despite those debates, there is scholarly agreement that intuition *can* be trained (Calvo-Porral & Lévy-Mangin, 2014; Eubanks et al., 2010; Iannello et al., 2020; Myers, 2007; Raio et al., 2012) and that we need to acknowledge and keep separate the different forms of intuition and their characteristics, such as expert or lay intuition (Kahneman & Klein, 2009; King & Clark, 2002; Rosen et al., 2010; Salas et al., 2010). For instance, expert intuition relies on domain expertise. Our effort to tap into the educational potential of the intuitive mind does not engage with these sometimes-heated debates but focuses on the need to find paths to improve intuition by gathering research that shows the clear potential to be further developed. This enables us to identify methods by which people can make better use of intuition. We are motivated by the argument that in addition to building a repertoire of analytics, we must pay appropriate attention to developing our intuition to cope with the complex and uncertain world of the future.

For decades, scholarly interest in intuition has emphasized the importance of gaining intuitive experience and expertise (Eubanks et al., 2010; Iannello et al., 2020); this is true across research domains like sports (Ferguson, 2013; Micklewright et al., 2017), security (Klein et al., 2010; Okoli et al., 2016), health (Gobet & Chassy, 2008; Quirk, 2006) and management (Bierly & Gallagher, 2007; Sadler-Smith & Shefy, 2004; Simon, 1987). Intuition's multifaceted applicability and its interdisciplinary impact are in line with ETH's Strategy and Development Plan. Although there is consensus that intuition can be improved with practice over time (Lufityanto et al., 2016; Mikels et al., 2011), precisely how to achieve that remains unclear, as does the extent to which it can be trained. Scientists have already started to train machines to decide intuitively (Gibney, 2016; *Nature*, 2016), even though we do not yet know how to train humans' intuitive decision-making. Educational policies such as those of the Organisation for Economic Co-operation and Development (OECD, 2014, 2019a,2019b, 2021) highlight that lifelong learning skills like intuition will be increasingly vital. Thus, we tackle the following research question: *How can we train our skill at using intuition deliberately?*

We have computers and machines that can replicate rational thinking, but that is the easier cognitive style. Beyond the potential shown by several traditional approaches for training intuition as a skill, new technologies have opened up promising but still largely unexploited pathways to train intuition. Thus, we focus on new training approaches like digital experiential tools (Fernández-Pérez et al., 2014; Kuo et al., 2009) that enable training intuition in a safe environment. Virtual reality (VR) tools can provide real-world exercises to intensify the effects of training (Checa & Bustillo, 2020; Jensen & Konradsen, 2018; Krokos et al., 2019; Radianti et al., 2020). VR is a graphic-based technology that provides a realistic experience viewed passively by users (Blair et al., 2021; Lampropoulos et al., 2021; Slater & Sanchez-Vives, 2016). Overall, highly controlled VR facilitates validity, reliability and generalizability (Matthews, 2018; Paschall et al., 2005; Persky & McBride, 2009). It offers an intensive experience where feedback can be provided, received and reflected on in a safe but realistic environment (Persky & McBride, 2009). This opens the possibility of enhancing skills through behavioural training interventions (Owens, 2018; von Bastian et al., 2022). Moreover, prior studies theorize – but do not empirically demonstrate – that VR can facilitate intuition (Ambinder et al., 2009; Seligman & Kahana, 2009). Overall, research shows that individuals using VR performed substantially better than those in traditional training environments (Argento et al., 2017; Schuster & Glavas, 2017; Wu et al., 2020) due to advantages like experiential learning (Persky & McBride, 2009). However, whether this outcome holds true for training intuition has not yet been studied.

The main contribution of our work is to outline possible avenues for training intuition through the use of new technologies and to advance this line of research. This is to enhance the understanding of intuition as a key research area. From a theoretical perspective, we emphasize that the complexity of intuition requires an abductive approach that applies multilinear, sense-making, and theory-building knowledge (Reichertz, 2019; Sætre & Van de Ven, 2021; Thatcher & Fisher, 2022).

## Theoretical foundations

Our learning framework to enhance intuition is based on complementary theories such as behavioural learning (Shuell, 1986; Skinner, 1989) and experiential learning (Hawk, 2011; Kolb & Kolb, 2005, 2017; Temple et al., 1979), in rewards are used to show the consequences of intuitive behaviour and provide knowledge about using intuition through pattern recognition procedures.

New learning approaches like digital tools and games are increasingly popular (Fernández-Pérez et al., 2014; Checa & Bustillo, 2020). For instance, games can identify intuition and analytical thinking (Kuo et al., 2009). Some scholars describe VR as the quintessential learning aid of the 21st century (Rogers, 2019), and VR exercises are expected to have widespread impact on learning (Krokos et al., 2019). VR even has the potential to change learner behaviour according to recent literature (e.g., Checa & Bustillo, 2020; Jensen & Konradsen, 2018; Merchant, et al., 2014; Radianti et al., 2020). In VR exercises, learners receive either rewards or punishments for their decisions and can grasp the consequences of different behaviours (Shuell, 1986; Skinner, 1989). Experiential learning helps people use analytical skills to reflect on what they have undergone or witnessed (Kolb & Kolb, 2017). Generally, new technologies show the potential to develop new and effective pedagogical practices.

## Methods

### Ethics Information

This research complies with all relevant ethical regulations. It does not require approval by the ethics committees of ETH Zürich, as our review is built on publicly available information and does not engage with any human subjects. All materials, such as the maps, the underlying data set and our recorded conference presentation of the Academy of Management in 2022, are available online at https://osf.io/pwdsx, while peer review can be undertaken at https://osf.io/pwdsx/?view_only=1f34f1ae795148c38fe788d3229268ca.

### A systematic mapping study

Because research related to intuition is underdeveloped and scattered across many disciplines (e.g., neuroscience, biology, management, education, psychology), a mapping study offers a crucial first step in analysing how to further study the deliberate training of intuition.

In this quantitatively driven, systematic mapping study, we analyse bibliographic information using statistical methods and bibliometric techniques such as co-citation mapping and bibliographic coupling (Braun, 2005; van Leeuwen, 2004). Grouping more than 90% of the relevant research by intellectually mapping connections makes bibliographic analysis highly accurate and reliable (Boyack & Klavans, 2010). In a systematic co-citation mapping study, paired or co-cited research documents are weighted and statistically scaled (Osareh, 1996; Pilkington & Teichert, 2006) to reveal invisible connections (Gmür, 2003) and enable the associations between documents to be explored (White & Griffith, 1981). To present these relationships in bibliometric maps, we use the analysis software tool VOSviewer and take advantage of a multidimensional algorithm (van Eck & Waltman, 2009; Waltman et al., 2010).

VOSviewer automatically assigns items to clusters based on bibliometric characteristics without allowing users to interfere or adjust the number of identified clusters. The researcher can only merge small clusters with larger ones[3]. Publications positioned close to one another on the map indicate connection: the greater the degree to which identical references are quoted in articles, the stronger the bibliographic link between those articles (e.g., Boyack & Klavans, 2010; Zhao & Strotmann, 2008). This algorithm has been widely implemented in

[3] For more information, please refer to the latest manual at www.vosviewer.com.

several disciplines (van Eck & Waltman, 2009, 2010, 2014). The broad scope of the intuition literature allows the clusters to be qualitatively interpreted with respect to the research question. Thus, a specific number of clusters does not necessarily have to lead to the same number of future research avenues. This approach allows us to highlight the potential of training methods that could work across disciplines because of their connections to a wide range of scholarly domains.

## Bibliometric data processing

The aim of this mapping and clustering analysis is to systematically explore educational research dedicated to training intuition. We used a well-defined keyword strategy and the Web of Science database to identify peer reviewed documents published between 1990 and the end of 2021. To visualize our bibliographic mapping analysis, we took the following two key steps:

(1) *Database and search strategy*[4]. We collected all publications in Web of Science and used synonyms reflecting humans' two cognitive styles: rational decision-making, intuitive decision-making, analytical thinking, experimental thinking, linear thinking, nonlinear thinking, gut feeling, intuition and deliberation. We explicitly used both cognitive styles in our search strategy as they cannot be clearly separated when being trained in adults, especially in more recent educational tools that simultaneously train the intuitive and the analytical mind (Owens, 2018). Next, we used keywords to capture training aspects: training, enhancement, improvement and education. Finally, we used common words that refer to finding innovative solutions: technology, tool, device, VR and augmented reality (AR). Our review focuses on the potential to train intuition by taking advantage of 21st-century learning aids like digital tools, VR and games (Kuo et al., 2009). We explicitly used VR and AR in light of scholarly work predicting that those tools will be central learning technologies in the future. A total of 7,680 peer reviewed documents published through the end of 2021 were retrieved; these papers were written by 166,649 authors and contain 253,986 references.

(2) *Software tools for mapping and clustering.* To produce bibliographic co-citation maps, we used VOSviewer v. 1.6.15, an open source software package developed by van Eck and Waltman (2017). VOSviewer classified the documents into relevant clusters based on maps that we drew. Because our primary aim was to provide insights for future research, we mapped keywords used in abstracts and titles to identify key discussion clusters and authors and thus direct researchers to those authors and papers for closer inspection.

We used co-citation and bibliographic coupling maps to highlight important ongoing discussions by the most deeply engaged authors while analysing peer reviewed documents' titles and abstracts that show promise for future research paths dedicated to training intuition with the latest educational technology. In other words, we explored the clusters qualitatively with respect to our research question: How can we train our skill at using intuition deliberately? We analysed each cluster separately and in parallel to explore all avenues across clusters that might help identify and refine methods to train intuition. This approach enables us to derive suggestions for future research paths across clusters while still acknowledging highly influential documents and leading authors.

[4] Web of Science search strategy: (ALL=(rational decision-making) OR ALL=(intuitive decision-making) OR ALL=(analytical thinking) OR ALL=(experimental thinking) OR ALL=(linear thinking) OR ALL=(nonlinear thinking) OR ALL=(gut feeling) OR ALL=(intuition) OR ALL=(deliberation)) AND (ALL=(training) OR ALL=(enhancement) OR ALL=(improvement) OR ALL=(education)) AND (ALL=(technology) OR ALL=(tool) OR ALL=(device) OR ALL=(virtual reality) OR ALL=(augmented reality)); books excluded; publication year between 1990 and 2021.

## Results

Figure 1 illustrates the distribution of the analysed documents from 1990 to 2021.

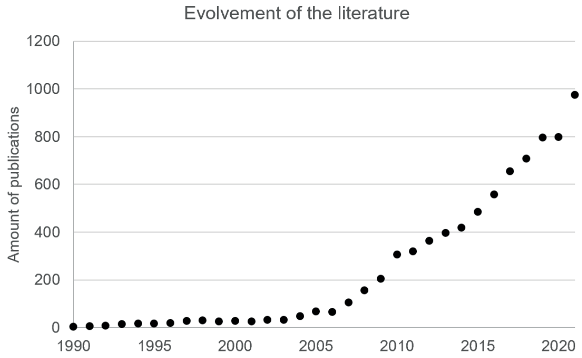


*Figure 1: Time frame of the analysed documents.*

Figure 2 is the first cluster map and is built on titles and abstracts. There are four main clusters, each highlighted in a different colour. The red cluster features studies related to training and aspects of methodological research. As expected, we see a lot of work related to experiments with control groups to detect how to train diverse cognitive skills. The yellow cluster depicts the literature dedicated to intuition from a medical perspective. Keywords are related to duration and time frame, which highlights the importance of long-term investigations and repeated measures. In this regard, research related to dream incubations and intuition measurements and technology related to heart rate variability and brain are discussed. The blue cluster also relates to health but focuses more narrowly on cognition and research related to the body, such as binaural audio technology that captures different beats that facilitate different brain waves. For example, an audio mix of different beats played in each ear could stimulate a particular state of consciousness – intuitive or analytical – that is linked to the brain (Berger & Turow, 2012). While beta brain waves facilitate the analytical mind, theta brain waves arouse the intuitive mind (Jovanov & Maxfield, 2012). Finally, the green cluster calls attention to experimental results related to intuition and brings organizations into the discussion. The results shown on this first map make clear how intuition touches on the full range of soft skills that are expected to be central in the rest of the 21st century.

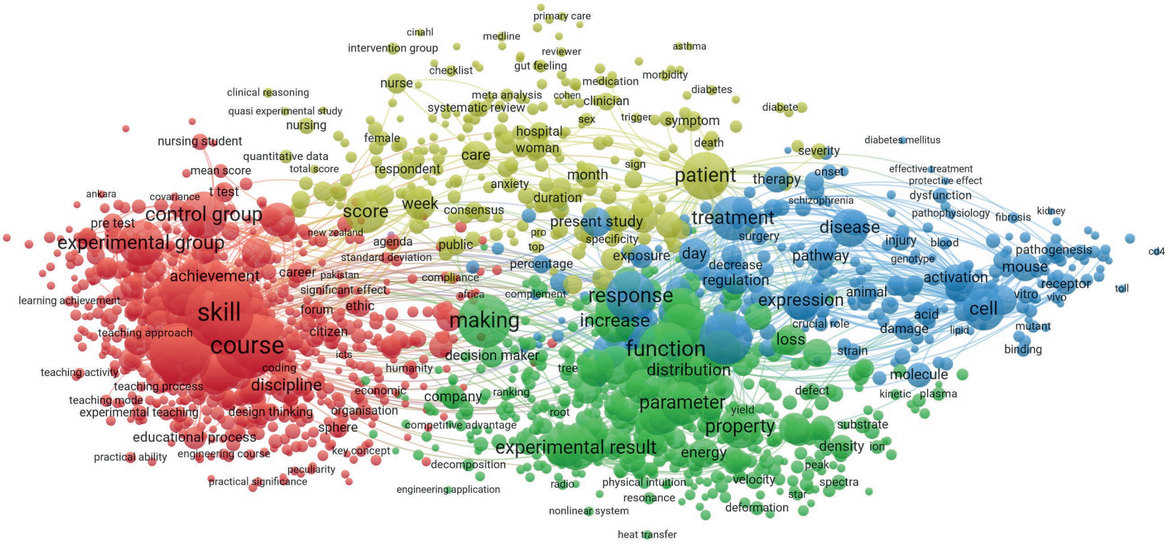


*Figure 2: Cluster map based on publication titles and abstracts retrieved from Web of Science from 1990 to 2021. Terms were extracted from title and abstract fields, ignoring structured abstract labels and copyright statements. A binary counting method was used so that only the presence or absence of a term in a document mattered; the number of occurrences of a term in a document was not taken into account. The minimum number of occurrences of a term was set at 10. There are 143,244 terms,*

*of which 4,105 meet this threshold, and 1,863 words shape four central clusters. There are 269,365 links.*

Figure 3 is the second co-citation map; it is clustered by authors who spent significant portions of their careers on intuition or related topics. Unsurprisingly, in the yellow psychological cluster we see Daniel Kahneman, whose *Thinking, Fast and Slow* (2011) is a crucial milestone in measuring intuition. There is a green cluster around John Dewey (Dewey, 1910; Dewey & Bento, 2009), a pioneer of critical thinking and experiential learning. As intuition is improved through experience and practice, it is no surprise that Dewey plays a significant role in research that deals with training intuition. Another familiar name is Jacob Cohen (1968; Wassertheil & Cohen, 1970), a leading statistician who laid important groundwork for empirical research. This highlights the need to have solid and robust measurements of intuition if we are to successfully train it. This must be kept in mind, despite the challenges posed by the subconscious and multifaceted nature of intuition. Tackling the challenge of training intuition requires new approaches and cooperation between researchers. The cluster in purple is led by Jeannette Wing (2008), who wrote a foundational work about computational thinking, which represents a universally applicable attitude and skill set that everyone – not just computer scientists – would be eager to learn and use. The red cluster is dominated by Weize Wang (W. Wang & Liu, 2013), who wrote several papers about human factors in computing systems and guided research related to highly useful technology for teachers. In this regard, VR has shown the potential of education to change behaviour (Krokos et al., 2019). Finally, the brown cluster is dedicated to creativity and led by Paul Torrance (1968, 1972), in recognition of his work on discovery and nurturing giftedness and his Torrance tests of creative thinking, which assess how creatively a child's mind works; they are often given to children to determine advanced placement or as part of entrance examinations. Torrance tests are very different from intelligence and reasoning tests that children may have already taken. Instead of traditionally taught subjects such as reading or math, these tests assess creativity. This is also very promising, as studies suggest that children who have not been taught rational skills are somehow still very skilled at intuition (Schlottmann & Wilkening, 2012). Thus, children can serve as a kind of role model because their analytical minds do not interfere as quickly or profoundly as adult minds. Overall, the ongoing debate highlights the fascinating interplay between intuition and imagination. These experts from a diverse set of fields – statistics, education, sociology, management, creativity and psychology – once again emphasize the interdisciplinary nature of training intuition, which of course creates challenges for us as intuition researchers.

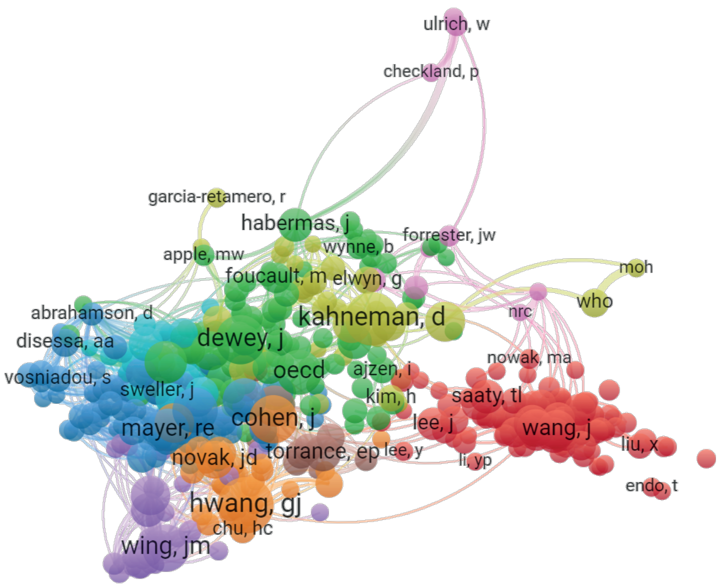


*Figure 3: Cluster citation map based on authors retrieved from Web of Science from 1990 to 2021. In this co-citation analysis, the unit of analysis is a cited author. The minimum number of citations as*

*author was set at 20; of 166,649 authors, 513 meet that threshold. Web of Science data include only the first author of a cited document, and other authors are not considered in a co-citation analysis of authors. The full counting method was used, which means that all occurrences of a term in a document are counted. Ultimately, 505 authors were associated with 20,684 links.*

Many other descriptive maps can be drawn, such as ones highlighting countries of origin and research organizations dedicated to identifying new training methods using innovative technologies for diverse cognitive skills. It is interesting but not especially surprising that the United States, Japan and China lead the academic discussion when it comes to training intuition, largely because most psychological research has been conducted in the United States, while the technological pioneers in digital education are found in China and Japan. A deeper dive into the organizations related to those countries and researchers clarifies that the University of Tokyo stands out for pioneering research in new educational technologies like VR. It is important to note that the difference between country and organization maps emphasizes the power of references to individual organizations. While the United States has numerous organizations, including Harvard, Stanford and Columbia, that play important roles in the discussion, Japan has fewer but more dominant institutions, such as the University of Tokyo and Kyoto University.

## Discussion and Conclusion

We conclude by returning to our central research question: How can we train our skill at using intuition deliberately? Our Web of Science data set comprises 7,680 peer reviewed documents published between 1990 and 2021. Using the VOSviewer tool, we explored 253,986 references to 166,649 authors who study cognitive decision-making styles across research domains. Based on our review, we have identified broad areas for future research on new methodological approaches that can help deliberately train diverse cognitive skills with novel technologies. We created two key maps showing what has been done so far and who has conducted research in combining thinking styles and educational purposes, as well as promising new educational technologies like VR. We conclude our work by highlighting the methods and approaches that show the most promise but require further research. Our work on this literature review reveals the following avenues for helping to discover and refine training methods for intuition.

(1) *Interdisciplinary frameworks and real-world efforts using new educational technologies like VR.* Our first map makes clear how intuition is interwoven across diverse disciplines in research that highlight the full range of soft skills that are expected to be central in the rest of the 21st century. Research on intuition has been conducted in a wide variety of fields: statistics, education, sociology, management, creativity, psychology and more. This emphasizes the interdisciplinary nature of training intuition, which of course creates challenges. In different fields of study, VR-related research has already shown promise for future investigations because it can be applied to the real-world situations that are crucial to studying intuition. Overall, VR shows enormous promise, particularly as a tool to simultaneously train the intuitive and analytical minds (Owens, 2018). Prior work suggests that intuition can be boosted by VR (Seligman & Kahana, 2009), as our environment plays an important role in directing our behaviour (Custers & Aarts, 2010), and behaviour in VR contexts does not differ significantly from real-life scenarios (Paschall et al., 2005). VR offers several advantages to the training environment (Argento et al., 2017; Schuster & Glavas, 2017; Wu et al., 2020), including incremental learning and automatic assessment (Persky & McBride, 2009). Multiple studies have shown that individuals using VR learning technology performed substantially better than those in traditional learning environments (Argento et al., 2017; Schuster & Glavas, 2017; Wu et al., 2020). Time travel with VR represents a valuable decision-making aid that

enables people to mentally experience decision-making and receive immediate feedback in a safe environment (Persky & McBride, 2009). Finally, VR offers greater scientific rigour by facilitating external validity and generalizability (Bainbridge, 2007). For instance, the greater learning impact of VR-based educational applications and exercises (Checa & Bustillo, 2020; Jensen & Konradsen, 2018; Krokos et al., 2019) offers opportunities to train intuition in a safe environment by allowing students to reflect on the consequences of certain (changes in) behaviours. This experiential learning is expected to lead to positive changes in intuitive judgment, feelings and skills (Kolb & Kolb, 2017). However, this ability also challenges us to design virtual intuitive experiences and real-life scenarios that we can study with genuine rigour, especially with respect to their impact on the development of intuition. Success in that effort would immensely enrich the scientific discourse. While the literature indicates that VR environments are better than traditional learning contexts in many fields, to the best of our knowledge there are no solid and robust longitudinal studies that support – or refute – that claim with regard to intuition. This is an area where intuition research can learn a great deal from the health sector. As Image 2 shows, there is immense research on intuition in nurses. In this discipline, the patient is at the centre because the patient is the person at risk. This also highlights that intuition is more reliable when facing risks or operating in critical or even life-threatening contexts (Hoffrage & Marewski, 2015; Kermarrec & Bossard, 2014; Klein et al., 2010; Okoli et al., 2016). The insights presented here could help prepare other research frameworks and teaching methods that focus on risky situations to increase the power to train intuition.

(2) *Other creative technologies and devices*. The publications depicted in Image 2 highlight other new technologies that could stimulate certain conscious states that simultaneously facilitate creativity and train intuition. For example, binaural audio technology (Berger & Turow, 2012) uses different beats to activate different brain waves and appears to offer an innovative way to train intuitive decision-making. This concept is partly driven by research on computational thinking (e.g., Wing, 2008) and creative tests (e.g., Torrance, 1968, 1972). Several wearable electronic devices have been discussed in terms of assessing intuition, especially in health and medicine research. These devices can explore and exploit the creative potential of dreams (Haar Horowitz et al., 2020) by automatically generating serial auditory dream incubations at sleep onset and thus facilitate imagination and creativity, both of which are connected to intuition. Others tools achieve synchronization between heart and brain through heart rate variability (e.g., Childre et al., 2000), though this approach has come in for criticism (Hagen-Foley, 2005). Of course, many other tools show the potential to facilitate intuitive innovative thinking and open new experimental avenues and novel teaching methods.

(3) *Advanced methodological approaches.* As statistically robust analyses are crucial for any research dedicated to either analytic or intuitive thinking styles, we conclude that there is immense room for methodological improvement when exploring the potential to train intuition. Overall, we need more short- and long-term empirical studies that employ both cross-sectional and longitudinal approaches and take advantage of highly controlled experiments in real-world settings or carry out field experiments. Moreover, mixed (pre and post) designs that combine within- and between-subject experiments and qualitative and quantitative methods, including traditional approaches like focus groups and interviews, could profoundly enrich the academic discourse. In this regard, VR studies can offer greater scientific rigor (Bainbridge, 2007). Overall, we conclude that beyond traditional methods like behavioural measurements and self-reports, we need to come as close to the real world as possible to prepare tomorrow's students to succeed by using their analytical skills and to excel by using their intuitive skills.

This systematic bibliometric mapping and visualization study offers first insights into and inspiration for how to train intuition, especially at pioneering higher education institutions like ETH Zurich. Moreover, it seeks to stimulate future empirical research and practice to explore methods that can help develop advanced teaching methods. However, due to the sheer breadth of intuition, the present study has certain limitations.

## Limitations

The aim of this work was to provide insights into how research could move forward to identify and enhance methods to train intuition. It is thus a first step on a long path and seeks above all to inspire future work in this direction. We have consolidated the relevant research that has been conducted to date; due to the nature of intuition, that scholarship is deeply interdisciplinary. We do not claim to have offered a full picture of intuition or how diverse cognitive skills can be trained with new technologies. Rather, we present a first review that serves to light the way to the next steps on the research path. We only touch on the most important, interesting and promising highlights of a highly diverse, vibrant and growing interdisciplinary topic. Our main aim is to inspire future research work.

Finally, we based our work on relevant keywords for the topic to ensure a comprehensive search. We identified several variations of keywords, synonyms, and related concepts. However, we note that further reviews with other keywords could lead to broader or narrower results. We have chosen the keywords that most closely reflect the current state of intuition training; of course, we encourage researchers to expand on this initial attempt.

## Theoretical implications

Our work highlights that, on the theoretical level, it is crucial to apply multi-lens, sense-giving and theory-building knowledge (Reichertz, 2019; Sætre & Van de Ven, 2021; Thatcher & Fisher, 2022). The learning framework to enhance intuition could be based on complementary theories such as behavioural learning (Shuell, 1986; Skinner, 1989) and experiential learning (Hawk, 2011; Kolb & Kolb, 2005, 2017; Temple et al., 1979). However, more detail is needed, because the exact mechanisms by which those theories could contribute to a new theory focused on intuition training are not yet clear.

Following Carver's recommendations (1972, 1974; Carver & Darby, 1972), developing a training method based on robust measurement requires careful attention to within-subject dimensions of growth. To empirically evaluate any training method’s validity, evidence relative to its sensitivity to growth is essential. In line with Carver (1974), evidence for the validity of any training measurement needs to be delivered across a diverse set of studies. Future research should be mindful that training is evaluated by performance growth and therefore must be designed so that results are meaningful without reference to self, rather than relying on comparisons with the performance of others. These are baseline requirements for any technology dedicated to an educational setting that will clearly be challenging.

## Practical implications

From a practical perspective, our work looks forward, exploring how to support tomorrow’s generations tackle complex problems by strengthening their intuition. The next generation of critical and creative thinkers will need to manoeuvre intuitively in highly complex situations to juggle the common good and the preservation of societal well-being, natural resources and the environment. In this context, intuition as a soft skill shows the potential to support people in analysing and developing new solutions and making decisions by using creative thinking. Highly realistic virtual worlds as educational tools offer unparalleled opportunities for both students and teachers to train their skills in a safe environment. For instance, intuition supports entrepreneurial thinking in risky situations, social skills related to health issues (Hoffrage & Marewski, 2015; Okoli et al., 2016), leadership abilities to manage humans and their emotions most effectively and the ability to analyse complex issues without knowing all the parameters. Research on intuition and experiments that include educators in intuition training could help future leaders navigate complex and uncertain environments and use intuition to make the best decisions possible (Gigerenzer & Gaissmaier, 2011; Johnson & Raab, 2003; Levitt, 2021;

Mousavi & Gigerenzer, 2014; Todd & Gigerenzer, 2007; Waroquier et al., 2010). Particularly in the face of risk and critical incidents, intuition has proven to be a fruitful resource even if it cannot always be explained in detail.

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