

# **Embedding reflective learning opportunities in teaching about intelligent systems**

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*Teaching and Learning Forum RISING*

## ***Intelligent Systems, related societal challenges, and the necessity for reflection***

Intelligent Systems, defined as systems capable to learn, network and show capabilities of (information-related) self-efficiency as well as environmental adaption, regardless of whether they are technical, biological, social, or cultural systems, infiltrate basically every aspect of our modern lives. While technical intelligent systems in particular are often assumed to make objective decisions, research shows that these systems are prone to inherit our conscious and unconscious biases, among other things (Dastin, 2018), and thus might not be as infallible as many times thought of.

One approach to circumvent or at least reduce maladaptive thought patterns, learned constructs and implicit biases goes as far back as Socrates: He already used targeted questions in dialogue to stimulate the learning progress of his students. Reflection therefore is not a new concept. At the heart of any reflection process are purposeful questions whose effectiveness varies according to the stage of the process (Daudelin, 1996). This process is defined by intellectual and affective activities that lead to exploring experiences to develop understanding and appreciation (Colomer et al., 2013). Systematic reflection as a metacognitive mechanism puts personal experiences into focus and thus represents the key to learning from one's own mistakes, but also from one's own successes (Ellis et al., 2014).

Existing research indicates that one of the benefits of systematic metacognitive reflection is the capability to plan better and faster (Becker & Lieder, 2021). Furthermore, planning strategies benefit from immediate improvements and people's decision-making competence increases (Becker & Lieder, 2021; Becker et al., in review).

## ***Implementing reflective approaches in teaching and learning***

In Higher Education, critical reflection as a didactical approach is a crucial training ground for the next generation, which serves as a foundation for lasting and effective changes. Characteristically, learners become aware of the demands of the task and take greater control over their own learning process, which are key characteristics of, and central to meta-learning (Biggs, 1985). Effective mechanisms of reflective learning include self-explanation (Chi et al., 1989) and counterfactual reasoning (Ellis et al., 2014). In the process of self-explanation, learners face the challenge of analyzing their own behavior and thus enriching explanations for success or failure with respect to pre-set learning goals. Counterfactual reasoning is characterized by picturing consequences of applying alternative behavioral strategies with regards to goal-achievement or invested mental effort.

Established methods and techniques to provide opportunities for reflective learning include reflective journals or diaries, reflective pre- and post-assessments (Tanner, 2012), role modeling, the use of questions in the form of prompts (Bannert, 2006), and critical incidents (Brookfield, 1990; Loughran, 1996; Seibert & Daudelin, 1999; Sparks-Langer & Colton, 1991). Debriefing is also used to help individuals reflect on their earlier experiences to derive meaningful insights (Thiagarajan, 1992). While studies have shown that they serve as a reflection tool to enhance learning strategies, they often lack capacities to promote lasting

mindset change (Hartung-Beck & Schlag, 2020). In an alternative route, Thiagi's approach of instructional design (Thiagarajan, 2005), a well-established training method used in corporate settings, touches a deeper level of understanding, and motivates people to achieve more effective changes. Through an interplay of training games and content that often on purpose leverages the moment of cognitive dissonance (Festinger, 1957), the learner can give personal relevance to new information, which in turn provides them the opportunity to learn and create new constructs and synapses. According to Thiagi, "people do not learn from experience; they learn from reflecting on their experience" (Thiagarajan, 2005, p. 109).

### ***Critically reflecting on intelligent systems in society (CRISS) at the University of Stuttgart***

Preparing the next generation for an ever-changing environment is of essential importance in Higher Education. Among the most important issues, cultural diversity has become highly prevalent in modern societies (Lee, 2017), bringing social biases and stereotypes into everyday life (Howard & Borenstein, 2018). However, many students are not aware of their own biases (Berberena & Wirzberger, 2021), which might have negative consequences since bias interferes with decision-making processes (Frederick, 2005). Hence, building capacities for critical thinking and self-reflection forms a crucial aspect of excellent education and is even more important to sensitize students to the social implications of prejudiced intelligent systems.

Addressing the outlined challenges, we developed a course framework focusing on critically reflecting on intelligent systems in society (CRISS), comprising both online modules and optional blended learning elements. In addition to providing means for understanding and applying critical thinking, we facilitate understanding of unconscious biases and stereotypes, and finally introduce approaches for practicing self-reflection and managing unconscious biases. To not only raise awareness towards pressing subject-related matters and topics but pave the way to lasting changes, our course design incorporates a variety of reflective teaching methods such as brief case studies – so-called "vignettes" – with related questions, thought experiments, brief sequences of activity that usually trigger a change of perspective (so-called "JOLTS"; Thiagarajan, 2005), or well-established psychological measures like the Implicit Association Test (IAT; Greenwald, Nosek, & Banaji, 2003) with subsequent debriefing.

By implementing critical reflection on intelligent systems across all study and graduate programs within the University of Stuttgart, we strive to broadly equip future generations to deal with potential societal and unforeseeable consequences of developing and applying new technologies with a critical and informed mindset.

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