Survey of AI-Based Systems for Human Awareness Promotion in Meta-Cognition

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Abstract: More and more AI-based systems are being developed and used for human awareness promotion. Human awareness promotion is important in various fields like those of learning and problem-solving where participants are expected to be aware of the changing contextual information of themselves and the environments around them to perform better. For a better computational supports of such promotions, AI-based approaches with particular reference to the mechanism of human meta-cognition seem to be plausible. In this paper, as an introduction to the session dedicated to this issue, we give a short survey on the definition of awareness and key factors of AI-based approaches to human awareness promotion.

Keywords: AI-based system, human awareness, awareness promotion, meta-cognition

I. INTRODUCTION

When we do something, we do not only do the task but perform a variety of mental activities related to the task. One of the most important performances among them is awareness. We humans are always aware of, and sometimes miss, something that may be related to the task we are doing. Then what and how are we aware of, and how can computational supports promote and facilitate human awareness?

In this paper, we will review the concept of human awareness and some key factors of AI-based applications for human awareness promotion.

II. AWARENESS AND METACOGNITION

Although we too often take human awareness for granted, the nature and characteristics of human awareness is not apparently obvious. In fact, researchers have discussed human awareness differently from different perspectives.

Most broadly, awareness is the mental state or ability of a person to perceive, to feel, or to be conscious of anything, from events that are happening, to the situation around him, to the conditions of himself. In this sense, awareness may not imply understanding what it is and what it means. From the viewpoint of computational support of the awareness, however, it is usually assumed that awareness implies understanding.

More specifically, awareness may be classified into several kinds: situational awareness, workspace awareness, knowledge awareness and self-awareness, though not limited to these.

Gutwin and Greenberg [1], for example, discuss human awareness as a situational one with which humans are aware of situational changes related to the task they are doing. They identified the following four basic characteristics of human awareness, as distinct from other kinds of knowing, according to [2],[3],[4].

1. Awareness is knowledge about the state of some environment, a setting bounded in time and space. For example, the environment might be the airspace that an air traffic controller is responsible for, and their knowledge might include aircraft headings, altitudes, and separation, and whether these factors imply a safe or unsafe situation.
2. Environments change over time, so awareness is knowledge that must be maintained and kept up-to-date. Environments may change at different rates, but in all cases a person must continually gather new information and update what they already know.
3. People interact with the environment, and the maintenance of awareness is accomplished through this interaction. People gather information from the environment through sensory perception, and actively explore their surroundings based on the information that they pick up.
4. Awareness is almost always part of some other activity. That is, maintaining awareness is rarely the primary goal of the activity: the goal is to complete some task in the environment. For

> example, the air traffic controller's task is to move aircraft through a region efficiently and safely, and although awareness may affect success, it is not the primary intent. ([1] pp.8-9)

Here, importantly, Gutwin and Greenberg clearly state that awareness is something related to the surrounding environment during the course of performing a task. Then they distinguish situational awareness from workspace awareness. Workspace awareness, they argue, is "the up-to-the-moment understanding of another person's interaction with the shared workspace ([1] p.10)," according to [2]. Note that their concept of workspace awareness is solely related to the people in the workspace and how they interact with it.

On the other hand, Ogata, Matsuura, and Yano focus on knowledge awareness in their seminal works [5]-[10]. They follow the definition of awareness by Dourish and Bellottie [11]: "understanding of the activities of others, which provides a context for your own activity," and define knowledge awareness as awareness of the use of knowledge. Knowledge awareness, they argue, "gives each learner information about other learners' activities in a shared knowledge space."[10]

Both Gutwin and Greenberg and Ogata et al. focus on the possibility of computational support for a successful group dynamics and the sharing of knowledge in the group. Thus computational systems to support awareness along these lines, including many studies on computer-supported collaborative learning/work (CSCL/CSCW), are inevitably designed to facilitate awareness of others' activities.

However, awareness can also be viewed as a mental activity of a single individual. In this context, awareness is captured as the monitoring of object-level in the metacognitive process, as shown in Fig. 1, and as the discovery of something useful for the task and/or the development of metacognitive ability. From this view-point, not only the awareness of what a learner is doing and the environment around him but also the awareness of his own mental state and process is focused.

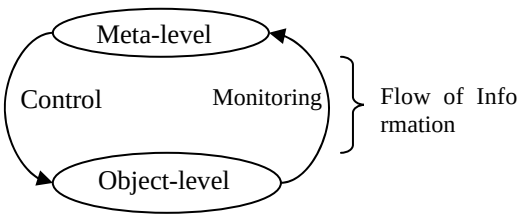

Fig. 1 Theoretical Model of the Mechanism of Metacognitive Process (Nelson and Narens 1990)

This concept of awareness is heavily related to the concept of self-regulated learning [13],[14]. According to the idea of self-regulated learning, learning is considered to be guided by metacognition, cognition in learning processes, and motivation, as shown in Fig. 2.

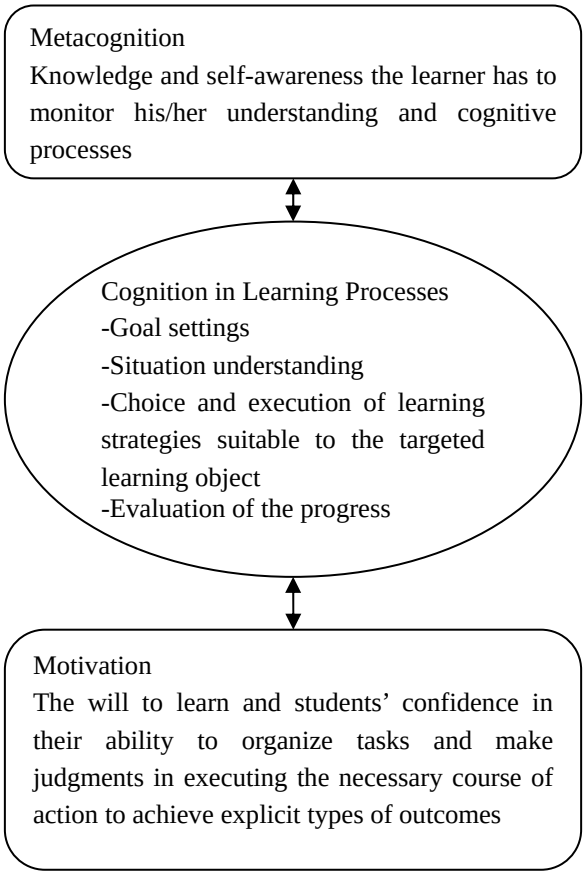

Fig. 2 Simple model of self-regulated learning

Here, what learners are supposed to learn is what a better learning is, as well as the learning objects. Thus, computational systems to support awareness along this line focus on facilitating or promoting awareness of self-condition compared to the desirable condition. There are numerous attempts along this line, including [15],[16],[17],[18].

Before leaving this section, note that these two different lines do not contradict each other. Rather, self-awareness can be boosted with the help of awareness of the others around him. Thus, the latter often focus on the cooperative or collaborative efforts in the group for a better self-awareness.

III. KEYS TO HUMAN AWARENESS PROMOTION

For promoting human awareness, whether it be

shared awareness in a group or self-awareness, there seem to be some key factors that must be considered: personalization or adaptivity, inferential model, effective information extraction, and explicitization or manifestation, though not limited to these. All these factors are expected to be supported effectively by AI-based systems.

1. Personalization or adaptivity

Naturally, humans differ from one another, not only in their preferences, characteristics, and socio-cultural backgrounds but also in their maturity and ability. Thus, any computational support system for promoting awareness has to adapt to individual learners in order to bridge the gap among different types of learners. In order to achieve this kind of adaptivity, the presentation of the domain knowledge and/or the learner's learning condition should be tailored in complexity and granularity according to his changing profiles. Formerly, this was achieved by preparing different profile-corresponding templates the choice of which was done by the learner himself. However, as expected, dependence on the leaner's choice do not always reflect the actual condition of the learner and the more detailed, the harder the choice will. This naturally requires the system to be driven by a inferential modeling in order to be intelligent enough.

2. Data-driven inferential model

If voluntary choices of preferences, conditions, and others, are not informed of by the learner himself, computational support systems have to obtain relevant information otherwise. For example, most web-based learner support systems make use of various records of user actions as well as conscious inputs by the users. All these data, however, speak nothing by themselves. A rather detailed mental/learning process model is needed. The model to be adopted may vary among systems, but due to the large number of possible complex combinations of the acquired data, more than a simple matching method will be needed, and AI-based methods have been utilized. In particular, more and more studies are pursuing the utilization of ontology as a descriptive engine for inferential reasoning. As for mental models in detail, see [19]-[25], for example.

3. Effective information extraction and mining

Modern computational support system for awareness promotion naturally have to deal with a great quantity of data both on learning objects and learner monitoring. Thus it has to be investigated what a better, effective way is to extract or mine the relevant, useful information, and to present it to learners.

4. Explicitization or manifestation

As we can walk without being consciously aware of inner muscle movements, we often do something without being aware of our relevant mental processes. However, the concept of self-regulated learning assumes that the more conscious, the better.. Sharing knowledge requires each to be conscious of what they know. Thus awareness, be it shared in the group or noticed by a single individual, involve the process of making the unknown or the hidden explicit to cognition. So computational support systems for awareness promotion has to do with effective explicitization of unknown or hidden information by persuading learners to turn their eyes to them.

VI. CONCLUDING REMARKS

This paper attempted a short, fragmental survey of awareness promotion, roughly consisting of review of the concept of awareness and key factors related to awareness promotion. To see more instances of computational support systems for awareness promotion, [26],[27] are a good starting point, together with the proceedings of annual ICWL, CSCWD, ICCE, and other related conferences and workshops.

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