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# Emotion-Adaptive Learning Systems for Transferrable Skill Learning

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## Extended Abstract

**Keywords:** Emotion, Transferrable skill learning, Adaptation, Learning process, Artificial intelligence

## I. INTRODUCTION

In traditional school education, acquiring factual knowledge is still the major focus. The advancement in artificial intelligence (AI) and the digitalization of socio-economical processes, however, have fundamentally changed the way humans work and live. Today, humans have the ability to access facts fast through smartphones, computers, and the internet. They can access this knowledge flexibly whenever they want. Thus, obtaining factual knowledge by heart has become less essential. In a fast-paced world, individuals must quickly adapt to new environments. Transferrable skills have become essential as they support humans to adapt to dynamic environments. They are seen as a key catalyst for helping the workforce adapt (ILO, 2021).

In general, it is important to understand the learners' emotions. Emotions control the learners' attention, influence their motivation to learn, and affect their self-regulation. Simultaneously, emotions involve subjective experiences that vary between individuals, even in the same situation (Pekrun, 2014). Traditional learning systems have mainly focused on cognitive processes of learning, but rather ignored the importance of emotions in learning processes (Scheu, Benke 2022). To suit the learning experience to the learners' needs it is essential to better understand the emotions in learning processes and how they influence the motivations and the learning outcome.

Sensor and AI technologies have opened the door to recognizing human emotions via biosignals capturing human activities such as speech, facial expressions, heart rate, or electrodermal activity. Leveraging these technologies together with the collection of subjective user perceptions of emotions paves the way for emotion understanding by an emotion-adaptive learning system. Integrating this emotional understanding provides new opportunities for the effectiveness and experience of learning systems. While it is important to comply with ethical requirements to protect the learner, it allows shaping the learning process with its steps, tasks, and goals to the individual learners' emotions. However, so far, the knowledge on the emotional processes in learning in general and transferrable skill learning specifically is scarce and so is, thus, the knowledge on the design of emotion-adaptive learning systems on when and how to intervene in the learning process to effectively influence emotions and the motivation of the learners. Therefore, we derive the following research question:

*How to design an emotion-adaptive learning system for transferrable skill learning to individualize the learning process and provide better learning experiences?*

To address this research question, we plan to conduct a research project following the design science research (DSR) approach (Hevner et al. 2004). As stated, there is a lack of design knowledge for emotion-adaptive learning systems that specifically focus on transferrable skill learning. The DSR approach is particularly suited to address this gap. We pursue to iteratively design and evaluate emotion-adaptive learning systems on the baseline of transferrable skill learning theory and previous knowledge on emotions in learning informing the artifact design (Hevner et al. 2004). In the following of this extended abstract, we will outline the conceptual foundation and describe our methodology.

## II. CONCEPTUAL FOUNDATIONS

This research project builds upon two important aspects of our DSR project: transferrable skills and emotions in learning systems. Together with knowledge and attitudes, skills are core elements of competencies (Weinert, 2001). They can be divided into fundamental, technical-specific, and transferrable skills. Transferrable skills have become more essential because they allow learners to adapt dynamically to new and changing circumstances (UNICEF, 2019). These skills serve as an umbrella term for cognitive, meta-cognitive, and socio-emotional skills like critical thinking, empathy, and communication (Chan & Fong, 2018; Olesen et al., 2020). Cognitive skills include logical reasoning. Metacognitive skills (e.g., decision-making, problem-solving skills) are necessary resources for an effective and competent performance. So far, research on interactive learning systems has heavily focused on these types of skills (e.g., Winkler et al., 2021). Finally, socio-emotional skills enable learners to regulate their behavior and emotions. Through their complementary character, socio-emotional skills influence the development and use of cognitive and metacognitive skills.

Emotions play an integral part in successful learning. Emotions are situation-specific, regulate interactions, and can be seen as constant companions in learning processes (D'Mello, 2013). The American Psychological Association defines emotions as reaction patterns involving experimental, behavioral, and physiological elements (APA, 2022). According to Izard (1994), emotions can be seen as amplifiers or dampers. As a result, emotions play an essential role in the active learning process for reinforcement, and they significantly impact the learners' ability to remember. Memories come to life when they are associated with emotional situations. Factual knowledge not associated with emotions is memorized differently and more likely to be forgotten. Consequently, for the learners' learning success, a positive perception of the learning situation is required. That is why humans' basic emotion recognition is also essential in digital learning environments (Gieseke, 2016). With the affective revolution at the beginning of the 21<sup>st</sup> century, research turned to investigate the role of emotions in the learning process. D'Mello et al. investigated in a meta-analysis discrete emotion in learning (i.e., general emotions such as joy or anger in comparison with continuous emotional dimensions such as valence and arousal). The findings show that detailed knowledge of specific emotions and their dynamics is still limited (D'Mello, 2013). In learning settings, the aim is to associate positive emotions with a learning process to achieve the most possible learning success. If this is not possible, it is critical to convert negative emotions like frustration into positive emotions to achieve learning success. However, recent digital learning systems still focus mainly on the cognitive and behavioral aspects of learning processes (Scheu, Benke 2022).

In general, there is a limited understanding of how specific emotions affect learning processes. As not every learner has the same ability to regulate their emotions, it is imperative to build an understanding of how emotional processes in learning take place. Learning processes must be adaptive and personalized. Above all, individualizing learning content is critical to match the learner at their current level of learning and emotion for providing the best possible support.

## III. METHODOLOGY

With our project, we want to address the research question of how to design emotion-adaptive systems for transferrable skill learning. The DSR approach is particularly suited for our endeavor

since it allows us to iteratively design and evaluate the emotion-adaptive learning system in a rigorous fashion (Hevner et al. 2004). The goal of this project is, therefore, to develop a design theory that gives explicit prescriptions for designing this class of artifacts (Gregor 2006; Gregor and Hevner 2013) based on the DSR framework proposed by Kuechler and Vaishnavi (2008). In the DSR process, we, first, identify issues in transferrable skill learning processes and emotions in learning processes. We start by reviewing extant literature from the education, the information systems (IS) and human-computer interaction (HCI) domain. Subsequently, we derive meta-requirements (MRs) (Hevner et al. 2004) for emotion-adaptive learning systems for transferrable skills based on the two underlying theoretical foundations, the theories of transferrable skill learning processes including cognitive, meta-cognitive, and socio-emotional skills, and the foundation of emotion-recognition and adaptation. Based on these MRs we will formulate design principles (DPs) addressing the MRs using the structure suggested by Chandra et al. (2015). The final objective is to evaluate these DPs in an experiment.

#### **IV. EXPECTED RESULTS**

Our central objective is to design emotion-adaptive learning systems for transferrable skills that can regulate the emotions and motivation of learners in learning processes. Through a DSR approach, we aim to develop prescriptive knowledge for such systems. We expect to design learning systems that leverage sensor and AI technologies to understand the emotions of the learners. The idea is to collect biosignals from the learner (for example by using smartwatches), derive emotional understanding from them, and apply the additional information to inform the learning system. To successfully use biosignals it is necessary to build upon AI-based classifiers that can derive emotions from biosignals. With emotion-adaptive systems, we aim to provide the learner who uses such an emotion-adaptive learning system for transferrable skills with a personalized learning process that is suited to the emotional processes at hand. Ultimately, this leads to a better learning experience. With the derived meta-requirements based on transferrable skill learning and emotions in learning, we first provide a thorough understanding that informs the design principles. In an experimental evaluation, we hope to provide evidence for the positive effect of individually adapted learning systems based on emotion on the learning processes. With this work, we contribute with a nascent design theory of emotion-adaptive learning systems for transferrable skill learning which builds upon the technological advancements of AI and sensor technologies for a better future of learning.

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