

On Psychological Aspects of Learning Environments Design

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Abstract. Psycho-pedagogical theories provide a valuable input for learning. Our goal is to identify requirements for learning environments, conceptually evaluate them, and integrate them into a psycho-pedagogically sound framework as a basis for the development of a highly responsive open learning platform. In this paper we first describe how personal learning processes are conceptualized in our Psycho-Pedagogical Integrated Model. To put our research into a context we review relevant literature on human decision making. Finally, we summarize the impact of our findings on the design of learning environments, considering principles of Self-Regulated Learning.

Keywords: Behavioral and Cognitive Psychology, Self-Regulated Learning, Design of Learning Environments.

1 Introduction

The research in behavioral and cognitive psychology [1, 2, 3] found out that humans err predictably and this knowledge can be harnessed to support them. The interplay between the different systems driving our thinking processes generates various fallacies. But choice architecture can influence options in a way that will support choosers to act in their own interest, preserving freedom of choice [3].

We see a challenge in investigation of possible consequences for requirements of learning environments. Our aim is to investigate relevant psychology outcomes for the design of future responsive learning solutions. Designers and developers of e-learning environments should take into account that humans have cognitive biases, which can make certain decisions very difficult, and therefore a suitable choice architecture is crucial. The current context provides clues for learning and an open issue is how technology should support adaptive learning in an appropriate way.

In the next paragraphs we first introduce our conceptualization of personal learning processes. A literature review shows principles of the human mind that generate heuristics and biases, but also outlines how choice architecture can help us to deal with uneasy choices. Afterwards we summarize the consequences for design of learning environments.

2 Learning Process Model

Current demands of lifelong and personalized learning made *Self-Regulated Learning* (SRL) [8] increasingly important in order to give the learner greater responsibility and control over all aspects of the learning process. SRL is guided by meta-cognition, strategic action (planning, monitoring, and evaluating progress), and motivation to learn. Self-regulated learners are aware of their academic strengths and weaknesses, and they have a repertoire of strategies they appropriately apply to tackle the day-to-day challenges of academic tasks.

One of the key objectives in the ROLE project [4] is to support the individual assembly of accessible learning services, tools and resources in responsive open learning environments, which permit personalization of the entire learning environment and its functionalities, i.e. individualization of its components and their adjustment or replacement by alternative solutions.

A psycho-pedagogically sound framework for supporting the individual composition of learning services [7] is being developed in order to support SRL. Five key interconnected aspects form the main principles of the ROLE *Psycho-Pedagogical Integration Model* (PPIM): Personalization and adaptability, Guidance and freedom, Motivation, Meta-cognition and awareness, and Collaboration and good practice sharing. The ROLE SRL process model is learner-centric, made up of three meta-cognitive learning phases [8]: Forethought, Performance, and Reflection. Including also the idea of self-profile for personalization, our SRL Process Model has four phases: Learner profile update, Selection of learning resources, Learning with selected resources, and Reflection on learning achievements.

From the implementation point of view the concept *Personal Learning Environment* (PLE) [10] is in line with the SRL requirements. PLE describes the tools, communities, and services that constitute the individual educational platforms that learners use to direct their own learning and pursue educational goals. Compared to course-centric solutions (like Learning Management Systems) PLE is learner-centric, i.e. students are in charge of their learning process, emphasizing meta-cognition in learning. From the technological point of view PLE is based on Web 2.0, usually implemented in the form of customizable portals or dashboards.

3 Behavioral and Cognitive Psychology

In this paragraph we review literature from several authorities in the field of behavioral and cognitive psychology. From our perspective these popularizing books provide a nice overview of the key outcomes in this field. They show principles of the human mind that generate heuristics and biases, but also outline how choice architecture can help us to deal with uneasy choices.

3.1 Human Mind

Human cognitive biases usually have a pattern – they are lawful, regular, and systematic. We can utilize these findings for our benefit, because when humans err predictably, this knowledge can be harnessed to help them [3]. Psychologists and neuroscientists [5] distinguish two kinds of thinking:

1. *Automatic system (AS)*: gut reaction, i.e. intuitive, instinctive (associated with the oldest parts of the brain) – uncontrolled, effortless, associative, fast, unconscious, skilled
2. *Reflective system (RS)*: conscious thought, i.e. rational, deliberate – controlled, effortful, deductive, slow, self-aware, rule-following

These two systems compete and complement each other, depending on the context, including available resources (e.g. time, energy). Research results in neuroscience shows that human decision making is based on the cognitive struggle between the brain's emotional and rational systems [5]. They can correct each other and we should learn how to control our thinking on a meta-level.

Apparently, the immediate context of decision making matters very much. A subtle influence can radically shift how people act. But the influences are quite predictable. Usually cheap metaphors and stories capture our minds. This has an enormous meaning for learning, but there is also a danger of oversimplification and misleading. Another issue is that school contexts for learning are very often highly artificial.

3.2 Choice Architecture

Now when we are aware of the limitations of the human mind, we may ask what practical problems we encounter as a consequence and how we can address them. The main candidates for alerts are uneasy choices [3]: *Delayed effects* (choices and their consequences are separated in time), *Difficulty* (some problems in life are complex), *Infrequency* (some decisions are rare), *Poor feedback*, and *Unclear impact* (ambiguous relation between a choice and its consequence).

Choice architecture has a huge importance for our decisions [3]. As a solution *libertarian paternalism* has been proposed, which preserves liberty and tries to influence choices in a way that will make choosers better off, as judged by themselves. This influence can be realized via suitable alerts or nudges. Such a nudge should alert people's behavior in a predictable way and at the same time it should be easy and cheap to avoid. The golden rule of libertarian paternalism says: offer nudges that are most likely to help and least likely to inflict harm. These are the basic principles of choice architecture: *Default options* (usually a lot of people end up with it), *Expect error* (a system should be as forgiving as possible), *Give feedback* (the best way how to improve our performance), *Understand mappings* from choice to welfare (options should be comprehensible), *Structure complex choices* (use the judgments of similar people to filter options), and *Incentives* (put the right incentives on the right people). So choice architecture is pervasive, unavoidable, and can have massive effects on people's behavior. The rules of libertarian paternalism can help designers and developers to preserve freedom of choice by providing gentle nudges.

4 Design of Learning Environments

A conceptual evaluation of the collected results is a necessary prerequisite for further implementation steps in the ROLE project. In this section we aim to summarize the impact of the above mentioned findings on the design of learning environments, considering the ROLE learning process model. In each of its four phases the learner

should be supported by suitable services mainly through appropriate recommendations [9] in order to follow the principles of self-regulation. As for the presentation of the recommendations choice architecture can play a crucial role, personalization and adaptability based on the learner's profile cannot be omitted.

Learners can encounter uneasy choices, like selection of a larger module, too many alternatives, lack of feedback and assessment, or unclear learning effect. In such cases it is required to simplify complex choices taking into account current constraints and learner's preferences. Suitable default options should be selected by experts and adapted accordingly to the learner and context. Social recommendations can narrow down the selection space automatically. Other suitable interventions include tutoring and peer assisted learning. The main principles include freedom of choice and a gentle nudge, when the freedom becomes overwhelming. A good solution requires identification of uneasy choices and application of a suitable choice architecture.

4.1 Learner Profile Update

In the first phase the learner profile information is defined or revised, considering input from various sources. This is crucial for personalization and adaptivity of the provided services. The profile data includes information on the learning goals, learner's competences, knowledge, skills, preferences, learning history and progress, etc. This data can be updated by the learner, her tutors and peers, as well as relevant services and tools. From the SRL perspective it is crucial that the learner herself decides who can modify her learner model and how. To get enough information on the learner, especially from the peers, it is required to put the right incentives on the right people. This feedback is a clear indication of the learner's performance. What is really critical here is appropriate visualization of the relevant changes, which has to be comprehensible for the particular learner, but should not cause unnecessary distractions.

4.2 Selection of Learning Resources

Reasonable *planning* of the learning process is needed, taking into account the learning objectives as well as existing constraints, like time and money. The main danger here is that people tend to make too optimistic plans, overlooking possible hurdles and unpredictable issues. In any case, the learner should be informed on the planned outcomes, consequences, and side-effects. As humans are emotional beings, they can be attracted and motivated by suitable design of all the dimensions of the learning experience – learning approach, environment, and all kinds of learning resources. It is crucial to choose an authentic context for learning and adjust it accordingly to the current constraints (available resources) as well as learner's abilities and preferences. This means that personalization, adaptation, and recommendation must be user and context dependent. In this phase of the learning process the learner searches for relevant learning resources to create her PLE. This includes communities, learning plans, activities, services, tools, content, etc. Based on her learner profile she obtains recommendations and from them selects the preferred ones. But too much freedom may become overwhelming and contra productive, therefore the learner can delegate some of these tasks to tutors, peers, and services.

Because of human fallacies the choice of the learner can be influenced by default options, understanding of mappings from choice to welfare, and structure of complex choices, where collaborative filtering based on experience of similar people in similar contexts can be extremely helpful [1].

4.3 Learning with Selected Resources

If the learning is to be deep, it is necessary to provide various perspectives on the same topic. The key knowledge and skills have to be repeated to be remembered. Therefore, redundancy is required on various levels – learning communities, plans, activities, resources, as well as their media representations. People like stories, but they may be misleading and oversimplified. Thus it is crucial to choose suitable analogies and metaphors. In addition to confirming examples, also counter-examples are important to demonstrate the validity of hypotheses and to assess risks. Both content and form of the learning experience are important and need to be chosen according to the learner's traits and the current context. SRL prefers recommendations to automatic adaptation, but structuring of complex choices should be personalized and adapted. Personalization is based on the learner's knowledge, experience, and preferences. Adaptation deals mainly with the context taking into account the current constraints and available resources. On one side it can mean selection of the best context to facilitate learning and make it authentic. On the other hand it includes also an appropriate adjustment of the current context according to the changing circumstances. In this phase the learner works on the selected learning resources. This is the actual *learning* phase, including also assessment activities that can change the learner profile. Good explicit assessment should provide neutral choices (e.g. multiple choice tests, free text answers). The learner has always the control over her profile and can adjust it accordingly. During the learning process the progress has to be monitored and the plan adjusted if needed. Default options and understanding mappings from choice to welfare play a key role here. Appropriate feedback to performed actions is the best way how to improve the performance of humans.

4.4 Reflection of Learning Achievements

Regular checking of learning outcomes is necessary to provide feedback by means of notifications on the progress, success, or failure. To find out the causes of learning success, one has to consider both successful and unsuccessful learners. The information retrieval principles and techniques can be used to find the distinguishing factors between those two. In this phase the learner is *reflecting* on the chosen learning strategies and her achievements, by trying to understand mappings from the former choices to welfare. She gets various kinds of feedback on her progress (e.g. learning history, assessment performance), processes it, and provides her own feedback, which may include updates in the learning plan or in the learner profile. This stimulates meta-cognitive activities of the learner.

5 Conclusion

Our aim was to investigate a possible impact of behavioral and cognitive psychology outcomes on design of learning environments. To overcome cognitive biases of humans a suitable choice architecture is crucial and libertarian paternalism has been suggested as a solution. It should preserve freedom of choice by providing suitable recommendations that are easy to avoid. We attempted to relate these findings to design requirements for learning environments, especially when self-regulated learning is considered. We think that also in this field decision making is essential for the quality of the learning outcome and should be supported properly to optimize learning for benefit of the learner. The conceptual evaluation of the achieved results is a necessary prerequisite for further implementation steps in our development of responsive open learning environments.

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