# Persuasive Systems to Support Behavior Change in the Context of Higher Education

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**Abstract.** The ongoing digitization of education and the accompanying requirement for self-direction exacerbates the long-standing problem that students in higher education lack self-regulated learning (SRL) skills. Here, Behavior Change Support Systems (BCSS) can provide students with missing guidance for improved learning behaviors and could therefore serve as a low-barrier intervention. But while such systems are established in the health context, deep research regarding their effects on students in higher education is missing. As the design and effectiveness of BCSS are strongly context-related, there is demand for investigation of their effects in a higher education context. This study introduces and evaluates a BCSS towards SRL. Using the perceived persuasiveness questionnaire, the study identifies multiple significant correlations with the perceived persuasiveness of the BCSS. Combining these results with the persuasive systems design model for BCSS design, we propose to further explore the design principles of the categories primary task support and dialogue support.

**Keywords:** Behavior Change Support System, Persuasive Technology, Self-regulated Learning.

## 1       Introduction

The progressive digitization of higher education and the resulting flexibility of learning. increasingly exposes students to problems in regulating their learning [1, 2]. Students with insufficient self-regulated learning (SRL) competencies run the risk of falling into a vicious cycle of failure [3]. SRL training can counteract negative consequences and alleviate perceived stressors [4], but struggling students, in particular, do not seek support or advice [3], due to a normalization of high-stress levels [5, 6] and high perceived barriers [6, 7]. Persuasive technology (PT) may function as a low-barrier addition to academic education. PT is established in the health context and successfully supports users towards a healthier lifestyle [8]. Here, PT provides missing guidance during behavior change processes that are typically self-directed [9]. As this is similar to students' challenge towards an improved learning behavior, PT offers great potential and easily accessible guidance. In form of Behavior Change Support Systems (BCSS) (such as smartphone apps) PT can easily be integrated into students' daily lives and could function as an effective, scalable, and low-barrier intervention [10]. However, while there are approaches towards PT in education, deep research on BCSS towards an

improved learning behavior is lacking [8, 11]. When developing new BCSS, their design and success are strongly context-related [12, 13]. This makes the careful selection of fitting design principles (DP) essential [14, 15]. Unsuitable DP can even lead to negative consequences [14]. To develop an effective BCSS for students in higher education, context-related design choices need to be investigated. As the goal of BCSS is to influence users' behavior "without using coercion or deception" [13] the research question of this study is: *How should a BCSS towards SRL be designed to be perceived as persuasive by students of higher education?*

Following Design Science Research (DSR) [16] the developed BCSS towards SRL resembles an artifact of a design cycle considering the knowledge base, including scientific theories and models, and students' environment [17]. The BCSS aims to integrate SRL holistically and offers students missing guidance for better learning behaviors. Therefore, the focus group of the BCSS summarizes a broad scope of students. This prototype enables theoretical contributions towards the effects of the BCSS on students and can provide design knowledge based on implemented DP. It further contributes to practice as it advises students on how to improve their learning behavior.

## 2 Theoretical Background and Design Framework

SRL comprises various models with different perspectives on effective learning [18, 19]. Self-regulated learners apply a set of learning strategies [18, 20] summarizing: 1) Cognitive learning strategies comprise the acquiring of new knowledge and storing it in memory. 2) Metacognitive learning strategies enable learners to reflect on self-set goals. 3) Internal resources comprise resources that are within the student, for example, stimulation and attention, while 4) external resources conclude additional support, for example, literature or contact other learners [21].

For the strategic development of BCSS, the Persuasive Systems Design (PSD) model is widely used. It suggests a three-step design process [13]: 1) The analysis of the persuasion context which includes the consideration of domain-specific issues based on the specific context of use, characteristics of the users of the BCSS, as well as the underlying technology. 2) An adequate selection of DP based on the findings of the concept analysis. Here, the PSD model provides 28 DP categorized into four groups: Primary Task Support, Dialogue Support, Credibility Support, and Social Support. This step is complemented by insights for user-specific guidance for DP selection [15]. 3) The requirement definition for software qualities and software implementation [13].

## 3 Designing a BCSS towards SRL

The design process of the BCSS follows the steps of the PSD model. In the context analysis, we considered findings of students' environment, SRL strategies, and the framework for user-specific DP selection [15]. Furthermore, design choices were iteratively tuned with two students (of the focus group). Based on these insights we incorporated nine DP of the PSD model [13]: *Self-monitoring*, *reduction*, *tailoring*, *liking*, *personalization*, *praise*, *expertise*, *tunneling,* and *trustworthiness*.

When opening the app students are introduced to a guided reflection. Based on this reflection on their current learning behavior, students get an analysis showing their strengths and weaknesses. Then, the BCSS recommends starting points towards an improved learning behavior. Using an app bar, students can switch through the 1) home feed, 2) repeat the reflection, 3) look at their learning analysis, 4) see steps towards an improved learning behavior, and 5) visit a wiki with information on each SRL strategy.
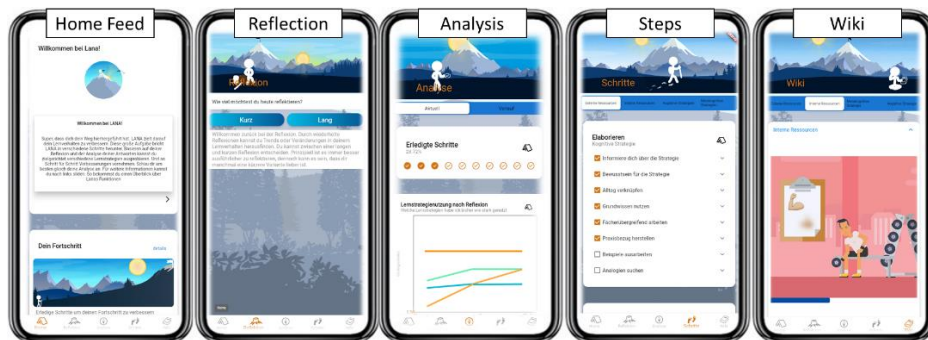


**Fig. 1.** Screenshots of the current version of the Behavior Change Support System

The **home feed** welcomes students and gives an overview and explanation of the core functionalities. It also contains a progress bar, where students can track their steps towards an improved learning behavior. Based on students' progress, *praising* messages appear (e.g., "Well done, the first steps are mastered!", or "Great job! Keep on going!". By adopting to students' names and progress *personalization* is addressed.

The **reflection** provides students with the opportunity to repeat their initial reflection. A regular reflection is advised to track changes in the learning behavior. Here, students can again decide to reflect in detail or select the short version. This option is added based on students' statements of an initial conducted evaluation of the BCSS.

The core of the BCSS is the **analysis**. It provides two options for *self-monitoring*:

a) The analysis of students' status shows the status of students' refection results as well as students' status of completed tasks. Furthermore, they get a detailed progress bar regarding each underlying SRL strategy. Besides, the BCSS provides two tiles suggesting concrete starting points (greatest potential for improvement and the largest number of steps not taken) (*tailoring*). These tiles list at least one SRL strategy.

b) Students can also view the analysis of their progress towards an improved learning behavior. A line diagram shows students' strategy use based on their conducted reflections. A bar graph provides students with information regarding their completed steps per week. Also, the reflection time per week is depicted.

The **steps** towards an improved learning behavior, give advice on how to apply SRL strategies step by step. This takes up *reduction*, as the task to improve learning is broken down into tangible steps. We incorporate *tunneling* by guiding students in the attitude change and providing means for action towards the target behavior.

When visiting the **wiki**, students are provided with a structured overview of videos and explanatory texts on SRL strategies. To take up students' wish for a more youthful

language (*liking*), we added short videos (up to one minute) in addition to explanatory texts. Furthermore, the wiki integrates *trustworthiness* and *expertise* by referring to studies.

## 4    Evaluation

We surveyed 21 first-semester IS students after initial 20 minutes of interaction with the BCSS. Our questionnaire comprises items of the Perceived Persuasiveness Questionnaire (PPQ) [22], excluding the construct social support, as no DP of this category is currently implemented. Some constructs did not meet the acceptance criteria for internal consistency ($\alpha < .7$). Therefore, the constructs perceived credibility (PC) and perceived effort (PEO) are excluded from further analysis. The other constructs show overall good internal consistencies ($\alpha = .78 - .90$). Table 1 presents the PPQ findings.

**Table 1.** Descriptive Data of Perceived Persuasiveness Questionnaire Constructs

|  | PTS | DS | U | PEC | UC | PP | PC | PEO |
|---|---|---|---|---|---|---|---|---|
| Mean | 3.70 | 3.74 | 3.77 | 3.83 | 3.68 | 3.55 | 3.89 | 3.59 |
| Min | 2.33 | 2.33 | 2.75 | 1.67 | 2.75 | 2.00 | 2.33 | 2.67 |
| Max | 4.76 | 5.00 | 4.75 | 5.00 | 5.00 | 4.67 | 4.67 | 4.67 |

PTS = Primary Task Support; DS = Dialogue Support; U = Unobtrusiveness; PEC = Perceived effectiveness; UC = Use continuance; PP = Perceived Persuasiveness; PC= Perceived Credibility; PEO = Perceived effort

The results show that students overall rate the constructs of the PPQ high, with mean scores from 3.55 to 3.83 (= "mostly agree") indicating that the prototype acts as a PT. The designed BCSS is perceived as persuasive by most students. Only two students did not rate the BCSS as persuasive. The overall agreement with the constructs PEC and UC supports the assumption that PT can be easily integrated into students' daily lives. Table 2 presents an overview of Spearman's rank correlation coefficient.

**Table 2.** Correlation of Constructs of the Perceived Persuasiveness Questionnaire

| Construct | PTS | DS | U | PEC | UC | PP |
|---|---|---|---|---|---|---|
| PTS |  |  |  |  |  |  |
| DS | .444* |  |  |  |  |  |
| U | .570** | .627** |  |  |  |  |
| PEC | .683** | .595** | .754** |  |  |  |
| UC | .680** |  | .438* |  |  |  |
| PP | .699** | .568** | .748** | .618** | .541* |  |

*p < .05; **p < .01

The exploratory data analysis identifies all constructs to be significantly correlated with PP. Indicating that when designing BCSS, designers should consider all constructs due to their positive relationship with PP. As the PSD model provides concrete DP within the categories PTS and DS, these constructs could act as starting points to further improve the PP of the BCSS. As the BCSS is overall perceived as persuasive by students, the implemented DP are supported.

## 5      Outlook to Future Research

The evaluation against the PP of the BCSS indicates a high PP. These findings are so far limited by the small sample size of 21 students; however, significant correlations could still be revealed. While the correlations show dependencies, no cause-effect relationships are yet presented. So far, the BCSS is not evaluated against its aim to improve students' learning behaviors. In future research, we aim to deepen our findings in two ways. 1) In laboratory settings, we plan to iteratively add further DP. By using different groups per integrated DP we can investigate the effects of individual DP and derive specific design knowledge. 2) In field settings, we plan to evaluate the BCSS within a lecture with about 350 students. Here we will measure students' levels of SRL using the questionnaire LIST [21] at the beginning of the semester. While we plan to publish the BCSS to one group of students, a control group will not get access to this treatment. At the end of the semester, we will again measure students' SRL, to identify the effects of the BCSS on students learning competencies. These evaluations might not only provide insights for DP as guidance for BCSS implementation but also for other systems with potential persuasive mechanisms on students such as learning management systems used by universities to communicate and exchange data with students.

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