Design Requirements for Behavior Change Support Systems with High Use Continuance: Insights for the Target Group of Students

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Abstract

To counteract the high academic stress of students and subsequent health problems, a behavior change support system (BCSS) for self-regulated learning is developed. Since use continence is a prerequisite for the system's supporting effects, this study examines design requirements that promote its use continuance. While previous studies on BCSS's use continuance are mostly quantitative using pre-defined constructs, this study additionally considers qualitative statements to exploratively identify additional requirements. Analysis of statements from 54 students and quantitative data from 25 students identifies 19 design requirements, which can be synthesized into ten meta requirements. These findings support the integration of already defined design principles, e.g., self-monitoring, but also reveal new requirements, e.g., a low-threshold character or the promotion of learning about the targeted behavior. The data also suggest that the design of the BCSS does not affect all students equally, but that perceptions of use continuance are dependent on individual preferences.

Keywords: Behavior Change Support System, Persuasive Technology, Use Continuance.

1. Introduction

This study investigates how the design of a Behavior Change Support System (BCSS) can affect students' use continuance (UC). The findings are based on a concrete BCSS that helps students improve their learning behavior to avoid emerging health problems caused by improper learning behavior. As typical for technology-based health interventions, users' UC is a necessary precondition for a positive impact (Walsh & Groarke, 2019). Studies show that students in higher education perceive high stress levels with academic stressors as the main stressor (Gazzaz et al., 2018; Ramachandiran & Dhanapal, 2018). This is of particular concern as sustained high stress levels lead to serious long-term problems: A high level of stress affects the students on a personal level and results in negative effects on their learning ability, academic performance, and mental health problems such as depression and anxiety, sleep disorders, as well as substance use (Pascoe et al., 2020). For years, anxiety and depression have been the most common disorders among American college students, with 34% of students that suffer from anxiety and 25% of students that are depressed (ACHA, 2021). These mental health-related problems among students can lead to significant impairments in intellectual, social, and emotional functioning and increase the risk of dropping out of studies, resulting in lower educational attainment, and even suicidality (Eisenberg et al., 2007; Keyes et al., 2012; van Ameringen et al., 2003). Without sufficient skills in academic learning, students are at risk of entering a vicious cycle of failure (Patel et al., 2015).

Training in self-regulated learning (SRL) can lower perceived stressors and counteract negative consequences (La Fuente et al., 2020). But despite the high incidence of mental health problems among higher education students, students with problems, in particular, do not tend to seek formal support, nor do they seek advice from their friends (Patel et al., 2015). Reasons include a normalization of high stress levels (Brown, 2018; Eisenberg et al., 2012) and high perceived barriers to support offers (Eisenberg et al., 2007; Stolzenburg et al., 2019).

Persuasive technology can provide a valuable, low-barrier supplement to academic instruction. Particularly in the form of smartphone apps, BCSS can be easily integrated into students' daily lives. They can provide missing guidance and could act as an effective intervention to help students improve their learning behavior and consequently prevent subsequent negative (mental-) health problems. However, the positive effects of the BCSS do not depend on their availability. Supporting BCSS can only achieve their full impact if they succeed in engaging and retaining their users (Lehto & Oinas-Kukkonen, 2015). Here, research shows, that users' characteristics can influence their perceptions of BCSS features (Oduor & Oinas-Kukkonen, 2021). But, so far, research on BCSS in general often understands users as a homogenous mass without considering smaller user groups (Oinas-Kukkonen, 2013). Consequently targeting learning behavior change with students as user

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groups is not sufficient (Merz & Ackermann, 2021). Besides, research on BCSS often lacks a precise description of evaluated BCSS (Oinas-Kukkonen, 2013). Addressing this research gap, this study presents and evaluates a BCSS for SRL for higher education students and investigates design requirements that promote students' UC.

The underlying research question is: *How should a BCSS for SRL be designed to achieve high UC among higher education students?*

This study contributes in four ways: It 1) presents a BCSS for SRL designed following the Persuasive Systems Design (PSD) model (Oinas-Kukkonen & Harjumaa, 2009), 2) evaluates the BCSS using qualitative and quantitative data, 3) derives design requirements for BCSS with students as the targeted user group, 4) synthesizes meta requirements that enable the transfer of the findings to other health BCSS with students as the targeted user group.

The development of the BCSS is embedded in a Design Science Research (DSR) project according to Hevner (2007) and Hevner and Chatterjee (2010). Accordingly, the BCSS presents the artifact that is iteratively evaluated and adopted based on feedback. In this approach, the identification of design requirements is a prerequisite for the subsequent targeted integration of design principles for the revised artifact.

2. Theoretical Background

2.1 Behavior change support systems

Persuasive technology summarizes the research field of artifacts called BCSS (Fogg, 2003; Oinas-Kukkonen, 2013). Fogg (2003) defines persuasive technology as "any interactive computing system designed to change people's attitudes or behaviors". Within this research field, a BCSS is defined as an "information system with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception" (Oinas-Kukkonen, 2013). For the development of persuasive systems, Oinas-Kukkonen and Harjumaa (2009) developed the PSD model. To date, most developers of BCSS design their artifacts accordingly (Merz & Ackermann, 2021). Regarding the development process for BCSS Oinas-Kukkonen and Harjumaa (2009) define three phases: In the first phase, the consideration and understanding of issues behind persuasive systems are essential. In the second phase, developers should conduct a context analysis and define the intent, event, and strategy regarding the persuasion of the users. The final phase addresses the design of the system qualities. Besides, Oinas-Kukkonen and Harjumaa (2009) introduce 28 design principles for BCSS implementation which are grouped into four categories. Table 1 provides an overview of these categories and the 28 design principles.

Design principles
Primary task support Reduction, Tunneling, Tailoring, Personalization, Self-monitoring, Simulation, Rehearsal
Dialogue support Praise, Rewards, Reminders, Suggestion, Similarity, Linking, Social role
System credibility support Trustworthiness, Expertise, Surface credibility, Real-world feel, Authority, Third-party endorsements, Verifiability
Social Support Social learning, Social comparison, Normative influence, Social facilitation, Cooperation, Competition, Recognition

Table 1. Design principles according to Oinas-Kukkonen and Harjumaa (2009).

2.2 Self-regulated learning

SRL is an overarching concept that summarizes constructs that influence learning (Panadero, 2017). To date, different theoretical backgrounds map SRL from different perspectives, e.g. SRL as a learning process (Landmann et al., 2015). Overall, there is an overarching understanding, that SRL comprises a set of various learning strategies (Landmann et al., 2015; Zimmermann, 2011). These SRL strategies can be categorized into four superordinate learning strategies and are depicted in Table 2: 1) Cognitive learning strategies address how learners can acquire knowledge and memorize it. 2) Metacognitive learning strategies address how learners check and regulate their learning. 3) Learning strategies on internal resources comprise the management of resources that reside within learners. 4) Learning strategies on external resources address additional support (Wild & Schiefele, 1994).

Self-regulated learning strategies
1) Cognitive learning strategies Elaboration; critical thinking; organizing; repeating
2) Metacognitive learning strategies Goal setting and planning; monitoring; regulation
3) Management of internal resources Effort; attention; time
4) Management of external resources Other students; literature; environment

Table 2. SRL according to Klingsieck (2018).

To measure SRL, different questionnaires exist such as the LASSI (Weinstein et al., 1987), the MSLQ (Pintrich et al., 1993), and for German-speaking countries the LIST (Wild & Schiefele, 1994), as well as its shorter version, LIST-K (Klingsieck, 2018).

When designing the BCSS for SRL, we follow the PSD model by Oinas-Kukkonen and Harjumaa (2009).

Besides we also build on the insights of Merz and Steinherr (2022). The researchers present a model, that suggests specific design features for BCSS while considering users' stage of behavior change according to Prochaska and DiClemente (1983). For users, at the beginning of the targeted behavior change, Merz and Steinherr (2022) recommend implementing design principles that allow users to learn and notice links between the cause and effect of the target behavior. Accordingly, an important step in the BCSS for SRL is also the initial transfer of knowledge about SRL strategies.

2.3. Related work

A recent literature review on BCSS identifies the health context as the most common application context (Merz & Ackermann, 2021). In this context most studies report positive effects e.g. on smoking, drinking behavior as well as stress, anxiety, or grief (Oinas-Kukkonen, 2013). Health BCSS are typically implemented as web-based, interventions via SMS, social networks, or mobile apps (Oinas-Kukkonen, 2013). While there are some studies on persuasive technology to improve students' learning outcomes, detailed research on BCSS in this context is missing (Steinherr, 2021). Despite the different application contexts, BCSS can only achieve their full impact if they succeed to engage their users and foster high use continence (Lehto & Oinas-Kukkonen, 2015). Here, also other researchers addressed the demand to investigate constructs affecting the BCSS' UC:

Oduor and Oinas-Kukkonen (2021) revealed that about one-third of the construct continuance intention is explained by the implemented design feature of the following constructs: computer-human dialogue support, primary task support, perceived credibility, social support, and perceived competence. Here, primary task support has the strongest effect on users' continuance intention. They further identified that users' demographic characteristics influence their perceptions of persuasive design features. The results are based on a quantitative survey with 227 respondents, representing a heterogeneous user group with an age range of more than 20 years and different educational backgrounds from high school to a doctoral degree (Oduor & Oinas-Kukkonen, 2021).

Lehto and Oinas-Kukkonen (2015) evaluate constructs' effects on UC and show that perceived credibility has a significant relationship to the users' continuance intention. Social identification has a strong connection to perceived social support, which, in turn, has a significant effect on perceived effectiveness and continuance intention. Finally, perceived effectiveness has a significant impact on UC. The results are based on a survey of 314 female participants aged 19 to 73 with heterogeneous characteristics in terms of education, occupation, and relationship status.

In earlier research, Letho and Oinas (2012) identified perceived persuasiveness and unobtrusiveness with a positive significant effect on users' intention to use the system. Again, these results are based on quantitative data analysis of a heterogeneous group (N=172). However, different from Oduor and Oinas-Kukkonen (2021) this study, showed that age, gender, and education had no significant effect on the model constructed.

Within the education context, Steinherr (2021) evaluated a BCSS using the Technology Acceptance Model by Davis (1986). Findings of this study show, that perceived usefulness has a positive significant effect on students' intention to use the system, while perceived ease of use does not. The authors conclude, that in an educational setting, the content and topic of the BCSS are the most important feature of the system to foster a high intention to use the system.

Previous research, as well as the PSD model, show that the specific context of BCSS should be considered when designing BCSS (Oinas-Kukkonen & Harjumaa, 2009). Since Oduor and Oinas-Kukkonen (2021) identify user characteristics with a significant impact on the perception of BCSS, this study evaluates the designed BCSS in a smaller but more homogeneous user group of first-semester IS students which represents the targeted user group. Furthermore, different from this study, previous research often investigates design features affecting UC by using constructs that summarize different design principles, for example, primary task support, or dialogue support. Through the qualitative addition to a quantitative questionnaire, our study can identify further effects of underlying design features within design principle categories.

3. Designing a behavior change support system for self-regulated learning

3.1 Context analysis

We designed the BCSS for SRL following the suggested development process for BCSS development and initially conducted a context analysis (Oinas-Kukkonen & Harjumaa, 2009). The target users of BCSS for SRL are higher education students in general who are trying to meet the requirements of their studies. The focus is on students in their first semesters who are experiencing a change in their learning environment due to the change of educational institutions from high school to higher education. Therefore, impulses or guidance to cope with the new educational environments could be beneficial. Thus, the developed BCSS aims to address the whole concept of SRL to allow students to learn about different learning strategies and then integrate them into their learning phases if the strategies seem appropriate. Therefore, a BCSS that is easily accessible to students with a wide range of SRL strategies is needed to address the wide range of students at the beginning of their studies. Considering the PSD model, we summarize the context analysis in Table 3.

The intent
Persuader: The system is designed by lecturers. After providing students access, it works autogenous.
Change type: The system is designed to foster an attitude and behavior change. Initially, it provides an impulse for initial attitude change, this in the return triggers behavior change. Based on the experienced behavior change goal is to then achieve a sustainable attitude change.
The event
Use context: The system is designed to support students to implement an improved learning behavior.
User context: Users are encouraged to reflect on their learning behavior. Based on the reflection they get advice on which learning strategies can be improved and how to do so.
Technology context: The system is designed as a web app. Students get access to the BCSS by a shared link.
The strategy
Message: The system encourages students to regularly reflect on their learning behavior and introduces learning strategies that could improve the current learning behavior. The system is based on the concept of SRL.
Route: The system implements a direct route. They are guided to start with a reflection and based on this reflection they are again guided towards specific learning strategies that can be improved.

Table 3. Context analysis according to Oinas-Kukkonen and Harjumaa (2009).

Based on the context analysis and a previous DSR evaluation cycle of the BCSS (Steinherr, 2021), we selected eight design principles out of the 28 defined design principles (see Table1): personalization, self-monitoring, reduction, tailoring, praise, expertise, tunneling, and trustworthiness. The BCSS is named LANA (Learning ANAlysis). It is initially developed for German first-semester students and therefore in the German language.

3.2. Designed behavior change support system

When opening the BCSS students are welcomed: “It's great that your path has led you here. LANA can help you improve your learning behavior. This big task is divided into small stages so that you can get closer to this big goal step by step.” The following screen introduces students to a guided reflection on their learning behavior. Here students can decide to select a detailed reflection or a short one. The guided reflection is based on the 39 items of the LIST-K, to provide students with scientifically validated results of their SRL behavior. The shorter version is reduced to 17 questions and addresses students that would shy back from long reflection phases. This way, the BCSS can be *tailored* to students’ reflection preferences. Figure 1 shows the corresponding welcoming screens when starting the BCSS. Screen 3 depictures the user interface of one reflection question. After completing the initial reflection, the BCSS praises students for example “Well done!”. After students’ initial reflection they are guided to their learning analysis.

Figure 1. Welcoming screens of the BCSS.

The core of the BCSS is the home feed including an app bar at the bottom of the screen. The app bar enables students to navigate through the BCSS's core functionalities: 1) the home feed, 2) the reflection, 3) the learning analysis, 4) the steps towards an improved learning behavior 5) the wiki that provides information on each SRL strategy.

Figure 2. Screenshots of the BCSS.

The **home feed** (Figure 2) provides different tiles for students to scroll through. The first tile introduces students to the BCSS’s core functionalities. Furthermore, one tile contains a progress bar, where students can monitor their steps towards an improved learning behavior. Based on students’ progress, different messages appear under the visual progress bar, taking up praise, for example, “Well done, the first steps are mastered!”, or “Great job! Keep on going!”. Furthermore, students can edit the home feed by adding tiles for example a certain analysis tile (Figure 4 and Figure 5). The home feed depictures the integration *personalization* as it is adapted to students’ names and progress.

The **reflection** page (Figure 2) enables students to repeat their initial reflection. The BCSS suggests students to repeat the reflection regularly in order to track changes in their learning behavior.

The app bar also includes the navigation to the **steps**. The steps comprise tangible advice on how to improve the SRL strategies step-by-step. As this functionality breaks down the huge task to improve students' learning behavior into tangible steps, *reduction* is addressed. After completing the specific tasks suggested in each step, students can check a box and mark the steps as completed. For each learning strategy, there is the same initial step "Educate yourself about the SRL strategy". Per SRL strategy there is a short video and explanation text that introduce the strategy and its purpose to raise awareness. Listing further steps to apply the SRL strategy takes up the *tunneling*, as the BCSS guides students in the attitude change "by providing means for action that brings them closer to the target behavior" (Oinas-Kukkonen & Harjumaa, 2009).

The **wiki** (Figure 2) summarizes information on each SRL strategy by providing an overview of the different strategies including videos and explanatory texts on each strategy. Furthermore, the wiki considers *trustworthiness* and *expertise* by citing studies.

The core functionality of the BCSS for SRL is the **analysis** of students' learning behavior. The analysis integrates self-monitoring and enables students to monitor their learning behavior from two perspectives:

1) When looking at the status, students will find the following tiles shown in Figure 3.

Figure 3. Tiles of the status analysis.

The analysis of students' status depicts the status of students' reflection results and students' status of completed steps. Furthermore, they get a progress bar regarding each underlying SRL strategy. Besides the status bars, the BCSS also provides two tiles recommending concrete starting points to improve the learning behavior (greatest potential for improvement and the largest number of steps not taken). These tiles list at least one SRL strategy students can take up. With one click on the listed strategy students accesses the corresponding step-by-step advice to improve the learning strategy.

2) Students can also monitor their progress towards an improved learning behavior. Figure 4 depicts a line diagram that is based on data from conducted reflections. Two bar graphs depict BCSS usage by week.

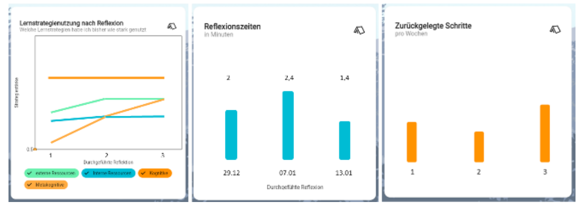

Figure 4. Tiles of the status analysis.

4. Evaluation design

The BCSS was presented in a mandatory soft skill course for first-semester IS students. The BCSS and its functionalities were demonstrated for 15 minutes. According to the recommendations of Ågerfalk (2013), the evaluation of the DSR artifact follows a mixed method by combining qualitative and quantitative data:

After the introduction to the BCSS, all 72 students were asked to answer the quantitative question in writing: "What should an app for improving learning behavior contain to make me use the app regularly?"

Besides, students could stay additional 15 minutes to test the BCSS by themselves and afterward evaluate the BCSS quantitatively. This quantitative questionnaire consists of two different questionnaires: To gain insight into the working mechanisms of persuasive technologies, we use the Perceived Persuasiveness Questionnaire (PPQ) presented by Lehto et al. (2012) and measures UC using 4 items. Although the literature indicates that the PPQ is not yet a comprehensively mature and not conclusively validated questionnaire, it explicitly takes up the design of BCSS and thus enables valuable insights (Beerlage-de Jong et al., 2020). Therefore, we include the constructs of the PPQ in our questionnaire, excluding the construct social support, since no design principle of this category is implemented in BCSS so far. In addition, we add constructs of the Learning Object Evaluation Scale (LOES). It is designed to capture the impact, effectiveness, and usefulness of learning objects (Kay & Knaack, 2009). This questionnaire can capture the aim of the BCSS to initially transfer knowledge about SRL to the users as an initial step towards behavior change. All constructs were measured using a 5-point Likert Scale, with 1 as "strongly disagree" and 5 as "strongly agree".

5. Results

5.1 Qualitative

In total 54 students answered the qualitative question (9 female; 45 male). Table 4 presents an exemplary identification of design requirements obtained from the content analysis.

Reward(-system)
Student #1: "You could introduce a reward system, where you get rewards for using it every day, and then you get some kind of prize when you reach certain point totals."
Student #2: "I would be motivated if you can reach different levels in the app and linked with a small reward "
Student #3: "I would especially like a reward feature, i.e., when you reach a goal or master a challenge"
…
Clear design and structure
Student #4: “I find a clear design and the simple control of such apps very important.”
Student #5: “It should have a nice and clear design. It should also be intuitive to use.”
Student #6: “The app has to be easy to use and I should be able to use it quickly and familiarize myself with it. I should be able to use it quickly.”
…

Table 4. Exemplary student statements.

Overall, 19 design requirements can be identified in students' answers. As detailed answers can address more than one design requirement, the number of mentioned requirements is higher than the number of participating students. Table 5 summarizes the findings.

#	Design Requirement (DR)	Mentions
1	(Push-)notification	15
2	Reward(-system)	12
3	Clear design and structure	9
4	Downloadable smartphone app	7
5	Game elements (levels, challenges)	5
6	Progress bar	4
7	Goal setting	4
8	Integrated learning plan	4
9	Subject-specific information	3
10	New content regularly	3
11	Social support	2
12	Integrability with university platforms	2
13	Expertise	2
14	Positive experience in first minutes	1
15	Helpful applicable advice	1
16	Blocking other apps when used	1
17	Less scientific terminology	1
18	Social comparison	1
19	Colorful design	1

Table 5. Design requirements for high UC.

The design requirement most students recommend is (push-)notifications. Students explain that notifications should appear on the smartphone screen and enable them to easily access the BCSS with one click. Topics of these notifications can be reminders e.g., to use the app at a certain moment, or notifications that new content is uploaded to the BCSS. Besides, many students suggest rewards within the app or a whole reward system that comes with a logical structure to earn rewards e.g., after completing specific tasks. Further, for students to use the BCSS regularly a clear design and structure should be recognizable in the BCSS. They demand an easy and intuitive handling of the BCSS functionalities. Complex or overloaded structures would discourage students to use the system. Seven students suggest that the BCSS should be a downloadable smartphone app instead of a web app. They request the BCSS to be easily reachable with as few clicks as possible. A smartphone app with an icon on the phone’s screen can fulfill this request. Besides, five students suggest adding game-design elements to the BCSS as a way to increase their motivation to use and interact with the BCSS. Mentioned game-design elements are levels, and challenges like daily quests. Furthermore, four students would like to see an additional progress bar, as a visualization of their behavior encourages them to further progress. While the BCSS already provides such self-monitoring options students suggest even more visual depictions of their progress. In conjunction with the desire for progress bars, students often request setting or targeting goals. Some students suggest linking the progress bar to set goals and monitoring progress toward those goals. Another design requirement students take up is a timetable or a learning plan. This plan should provide an overview of learning tasks and enable students to see when, how, and what new content should be learned. Besides this learning-specific request, students also wish for subject-related learning advice. As the participating students are IS students, they ask for concrete advice on how to study certain topics, for example, informatics, or math. Three students state that regularly updating new content would have a positive effect on their UC. They explain that updates and new information keep students interested when using the BCSS. Besides students suggest design requirements related to social support. They take up exchange opportunities with fellow students and networking functions to get in contact. Students also state that the integrability of the system is important. They recommend an interface to the university’s learning management system. Two students state that perceived expertise regarding the functionality of the BCSS fosters their UC. In addition to these requests made by various students, the following design requirements are stated by single students.

One student suggests designing the BCSS so that users have a positive experience in the first minute of use. Another student suggests integrating a feature that blocks other apps when using the BCSS to prevent distraction. Furthermore, one student requests easy language in the app. Scientific terms such as “metacognitive” can harm UC. One student suggests adding social comparison e.g., by including the comparison of progress bars of other users. Besides, one student requests a colorful design of the BCSS to stand out from other digital learning environments, e.g., the university’s learning management system.

5.2. Quantitative

The data is based on the answers of 25 students (7 female; 18 male). Table 6 shows the descriptive statistics of the PPQ.

PPQ	PT	U	PP	PE	UC	DS	PC	PEf
α	.82	.77	.84	.89	.88	.50	.50	.66
Mean	3.5	3.5	3.3	3.2	3.5	3.5	3.7	3.4
Min	1.7	2.3	1.3	2.0	1.0	2.3	2.5	2.0
Max	4.7	4.8	4.7	5	5.0	5.0	4.8	4.7
PT = Primary Task Support; U = Unobtrusiveness; PP = Perceived Persuasiveness; PE = Perceived Effectiveness; UC = Use Continuance; DS = Dialogue Support; PC = Perceived Credibility; PEf = Perceived Effort								

Table 6. Descriptive statistics and Cronbach's Alpha of the PPQ.

Three constructs of the PPQ did not meet the acceptance criteria for internal consistency (Cronbach's α < 0.70). Therefore, the constructs of perceived credibility, perceived effort, and dialogue support are excluded from further analysis. Overall, the mean values of the PPQ are good. Especially perceived credibility and unobtrusiveness are rated positively among most students. Students' UC is rated between a span of 1 and 5 showing the highest differences among the perceptions of individual students for all constructs.

Table 7 shows the descriptive data of the LOES.

LOES	L	Q	E
α	.83	.73	.70
Mean	3.7	3.8	3.7
Min	1.8	2.3	2
Max	4.6	4.8	5
L = Learning; Q = Quality; E= Engagement			

Table 7. Descriptive statistics and Cronbach's Alpha of the LOES.

Overall, the mean values of the LOES are good. Most students agree, that the BCSS functions as a valuable learning object, that transfers knowledge about SRL in an engaging way with high quality.

To identify significant correlations, we investigate Spearman's rank correlation coefficient. Table 8 presents an overview of significant correlations.

	PT	U	PP	PE	UC	L	Q	E
PT	1							
U	.59**	1						
PP	.74**	.71**	1					
PE	.75**	.75**	.68**	1				
UC	.64**	.63**	.59**	.46**	1			
L	.83**	.73**	.75**	.77**	.63**	1		
Q			.41*			.43*	1	
E	.80**	.60**	.76**	.61**	.82**	.80**		1
** The correlation is significant at the .01 level * The correlation is significant at the .05 level								

Table 8. Correlation matrix.

Exploratory data analysis shows that all constructs of the PPQ are significantly positively correlated with each other. As for the LOES, learning and engagement show a highly significant correlation with students' UC.

6. Discussion

While the analysis indicates concrete design requirements for BCSS for SRL, the following discussion synthesizes these concrete context-related requirements into more abstract but therefore more transferable meta requirements (Kaiya, 2018).

Based on the identified 19 design requirements within the qualitative data we can derive seven meta requirements, that are presented in Table 9. Table 9 also transparently presents the consolidated design requirements for each meta requirement (for DR # see Table 5).

To foster students' use continuance a BCSS…	
Meta requirement	DR #
needs low-threshold nature	1, 3, 4, 12
needs to motivate through incentives	2,5
needs to provide means for self-monitoring	6,7,8
needs to get students hooked to the system	10,12,14,16
needs to integrate social support	11,18
needs to provide clearly defined content	9,13,15,17
needs to have a friendly look and feel	17,19

Table 9. Meta requirements identified through qualitative data.

The first meta requirement is the low-threshold nature of BCSS. This is picked up in students' suggestions for (push-) notifications, which enable access to the app with one click. This is also addressed by the request for a downloadable smartphone app with a displayable icon on the home screen and the desire for a clear design and structure of the BCSS so that students can quickly get an overview of the app's functionalities and modes of operation without having to familiarize themselves with it. In addition, the integrability of the BCSS and interfaces to other systems students already use can help to provide students with easy and low-threshold access to the BCSS. Besides, students request incentives for example in the form of rewards systems or further game elements. Here, for example, studies such as Sailer et al. (2014) provide an overview of game elements that can also be integrated into systems such as BCSS. Self-monitoring is also taken up as a meta requirement. Progress bars, but also visible (self-)set goals or a learning plan enable students to plan their behavior and monitor progress. Students also indicate that it is important to become "hooked" when using the system. Specifically, they want new content regularly or an initial positive experience in the first few minutes of using the BCSS. Also, the suggestion to block other apps when using the

BCSS, can minimize disruption and fosters the possibility of "getting hocked". Another meta requirement is social support. Here students pick up exchange and networking with fellow students, but also social comparison. Further, the advice towards an improved learning behavior should be clearly defined. This is based on students' desire for expertise and tangible, applicable advice. The effect on the applicability is also connected to subject-specific information. The final meta requirement we identified in the qualitative statements is the friendly look and feel. This is based on students' wish for less scientific terminology and a colorful design.

By analyzing the quantitative data three further meta requirements are identified. Table 10 summarizes the three additional identified meta requirements.

To foster students' use continuance the BCSS…
needs options for tailoring
needs to foster learning about the target behavior
needs to engage students

Table 10. Meta requirements identified through quantitative data.

Students' UC is identified as the construct with the greatest differences in students' perceptions. While some rated the highest value of 5, others rated the lowest value of 1. This may indicate that students' perceptions of UC are dependent on personal preferences and design decisions do not resonate with all students in the same way. It empathizes the demand for options for tailoring. This way the systems can adopt to students' preferences. This seems to be especially important for design principles that are controversial, such as reminders. While some students see them as a way to promote the low-threshold nature of the system, others explain that pop-up reminders would make the BCSS seem annoying.

Analyzing the quantitative data of the PPQ, using a Spearman's rank correlation coefficient predicts interactions among the measured constructs. Consequently, cause-and-effect statements cannot be derived from individual constructs. This underscores the relevance of the context analysis in BCSS design, as design features appear to influence not only one construct but could also influence students' perceptions of the BCSS as a whole.

Besides its character as persuasive technology, the goal of the BCSS is also to transfer knowledge about the target behavior. Regarding the constructs of the LOES, learning as well as engagement correlate positively and with a high significance level with UC. However, the construct quality shows no significant relation to UC. Consequently, an engaging knowledge transfer could have a positive effect on students' UC. This goes in line with earlier identified research that identified that perceived usefulness has a significant positive effect on students' intention to use a BCSS (Steinherr, 2021).

These findings and design recommendations are based on students' statements and evaluations following their experience with BCSS for SRL. Although the design requirements are derived based on a specific context of use, the meta requirements might also apply to BCSS with students as a defined target group for BCSS outside educational contexts.

7. Conclusion

This study presents a BCSS for SRL, that is designed following the PSD model by Oinas-Kukkonen and Harjumaa (2009) and insights of Merz and Steinherr (2022). The overarching goal for the BCSS is to counteract the current high levels of students' stress and stress-related (mental) health problems that are caused by improper learning behavior. Because students' UC is a precondition for the system to guide students toward sustainable learning behavior improvement, this study aims to identify design requirements to promote students' UC. The qualitative data of 54 students present results in a list of 19 identified design requirements. With (push-)notification, a reward (system), and a clear design and structure as the most addressed ones. Furthermore, the quantitative evaluation reveals that students' perception of their UC with the system differs strongly. This indicates that personal preferences might also influence their UC. Besides, a Spearman's rank correlation coefficient analysis reveals, that multiple constructs of the PPQ are positively and highly significantly correlated to students' UC. These constructs summarize primary task support, unobtrusiveness, perceived persuasiveness, perceived effectiveness, dialogue support, perceived credibility, and perceived effort. Adding the LOES in the quantitative analysis, identified, that students' perceptions of learning and engagement, when interacting with the BCSS, are significantly positively correlated with their UC. Analyzing the identified design requirements reveals ten meta requirements to foster a high UC of students. Above all, the findings highlight the importance of a thoughtful selection of appropriate design principles, as single design features of the BCSS influence students' perceptions not only of individual constructs, but of several, and thus of perceptions and intentions to use the whole system.

8. Outlook and future research

The BCSS for SRL is designed following the PSD model (Oinas-Kukkonen & Harjumaa, 2009) and presents an artifact within a DSR project (Hevner, 2007). Consequently, the research project follows an iterative approach. Based on the findings of this study, the BCSS will be further revised. Considering the identified meta requirements for incentives and social support, we will incorporate the design principles rewards and social comparison. We also plan to evaluate different versions of the BCSS in an experimental setting, with each version of the BCSS integrating a single additional design principle. In this way, we aim to identify the cause-effect relationship in students' perceptions of the BCSS concerning individual additional design principles. In the long term, the impact of the BCSS on students' behavior, as well as its preventive effect on students' health, will be investigated.

While the ten identified meta-requirements were derived based on feedback from university students, they could also provide insights for related user groups such as higher education students or trainees in a company. However, following the PSD model and Lehto and Oinas-Kukkonen (2015), we recommend an underlying context analysis when developing new BCSS, rather than assuming overly homogeneous user groups.

The quantitative findings of the study are limited by the exploratory analysis. While we identified significant correlations, causality has not yet been investigated. The evaluation of the quantitative results is also subject to a certain degree of subjectivity. By showing an example of coding, we aim to demonstrate a certain transparency and comprehensibility. In addition, the applicability of the PPQ was not fully given. As three constructs did not meet the acceptance criteria for internal consistency, our analysis is based on five constructs. This might be due to the number of participants. Out of 54 students, only 25 also completed the quantitative questionnaire. In future projects, we aim for a higher number of participants. Following the findings of Beerlage-de Jong et al. (2020), we also support the demand for future research towards a more standardized and validated scale to measure the effects of BCSS.

Furthermore, while current research often analyzes the cause-effect relationship of design principle categories, future research could also investigate how the integration of single design principles affects users' perceptions of the system.

Future BCSS research could also consider whether the integration of design principles has a different effect on different user groups, as previous research has already indicated (e.g. Oduor and Oinas-Kukkonen (2021)). The distinction between user groups could be made not only according to demographic aspects but also, similar to targeted gamification, according to the personality traits and motivational structures of the users (Tondello et al., 2016). If there are significant correlations between users' characteristics and perceptions of individual design principles, this could provide a systemic framework for a targeted implementation of the design principles tailoring and personalization.

9. References

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