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LANA – A Behavior Change Support System towards Self-regulated Learning

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Completed Research

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Abstract

The measures to counter the COVID-19 pandemic add pressure on students to meet the challenges of digitized courses in higher education. Many suffer from these demands and fail to regulate their learning effectively. Behavior Change Support Systems (BCSSs) are a promising approach to guide students towards a successful learning behavior. Nevertheless, successful integration of the systems requires users' acceptance and intention to use. While BCSSs have been well studied in several research areas, there is insufficient evidence on the design features that promote the acceptance of BCSSs in educational contexts. This study presents LANA, a BCSS towards self-regulated learning that is designed following the Persuasive System Design Model by Oinas-Kukkonen and Harjumaa (2009). The evaluation using the Technology Acceptance Model by Davis (1986) shows that perceived usefulness has a significant impact on students' intention to use LANA and highlights the importance of considering the design of the user interface.

Keywords

Behavior Change Support System, Persuasive Technology in Education, Self-regulated Learning.

Introduction

The goal of this study is to identify crucial design features influencing the acceptance of a Behavior Change Support System (BCSS) towards self-regulated learning (SRL) in higher education. BCSSs accompany and guide users through the process of changing their behavior (Oinas-Kukkonen 2013). These BCSSs are successfully implemented in different research fields (Tikka and Oinas-Kukkonen 2019). Whereby a basic acceptance for technologies and an intention to use (IU) are essential prerequisites (Kim 2015).

Currently, BCSSs are successfully implemented in various fields, especially in the health care sector (Tikka and Oinas-Kukkonen 2019). Without BCSSs people often fail because the desired behavior change is mainly self-directed and therefore guidance and instruction are missing (Allan et al. 2008). Students in higher education currently face similar challenges, due to increasing digitalization that comes with the need to organize and regulate learning on their own (van Wyk 2017). Many suffer from this pressure (LeViness et al. 2019). Additionally, the COVID-19 pandemic measures further exacerbate these conditions as self-study takes on an even greater role in online-only semesters (Wesselborg 2020). Studies show that training in SRL can lower perceived stressors, prevent problems caused by bad learning behavior (La Fuente et al. 2020), and are already proven to be a valuable addition to cope with the challenges of digital semesters during the COVID-19 pandemic (Wesselborg 2020). But despite the increasing relevance of support for students, traditional trainings often do not reach their goals. Reasons are high perceived barriers regarding formal support services (Eisenberg et al. 2012; Stolzenburg et al. 2019), a normalized high level of stress in academic education (Brown 2018; Eisenberg et al. 2012), and insufficient effects, as new knowledge is quickly forgotten (Goh et al. 2012). BCSSs in form of smartphone apps can easily be integrated into students' everyday lives, provide missing guidance during digital semesters, and could therefore function as effective, scalable, low-barrier interventions to improve learning (Fogg 2003).

But although apps are typically considered attractive to students, there is still a risk that these technologies are not used or are only used with insufficient frequency (Teri et al. 2014). This underscores the fact that the successful integration of apps into educational contexts does not depend on the availability of the

offerings, but rather on students' acceptance and their IU. Therefore, it is crucial for newly developed technologies to evaluate their design and structure in terms of user acceptance (Kim 2015). So far, there is still a lack of studies investigating BCSSs underlying design choices and their influence on student's acceptance in higher education as the systems are not yet established in educational settings (Lehto and Oinas-Kukkonen 2015). Therefore, the research question underlying this study is: How should a BCSS towards SRL be designed to foster students' acceptance, in particular their initial IU?

To investigate this question, the BCSS LANA (Learning Analysis) is developed drawing upon the existing knowledge base identified through a systematic literature review. The design of LANA is in accordance with the steps of the Persuasive Systems Design (PSD) model by Oinas-Kukkonen and Harjumaa (2009). To measure students' IU, the Technology Acceptance Model (TAM) (Davis 1986) is combined with qualitative feedback to identify design features influencing target users' IU. This paper provides researchers and developers of Persuasive Technologies (PT) input regarding the design of BCSSs in educational contexts.

Theoretical Background

Behavior Change Support Systems

Fogg (2003) highlights the potential of PT to help people during behavior change processes, as technology is already an inherent part of our daily lives. He defines PT as "any interactive computing system designed to change people's attitudes or behaviors." (Fogg 2003, p. 1). According to Fogg, the advantages of using PT include time and location independence, scalability, ubiquity, and anonymity. These advantages lower barriers to use PT (Fogg 2003). While PT names the field of research, BCSS is considered as the research object. Oinas-Kukkonen defines BCSS 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" (2013, S. 1225). A framework that addresses the development process of BCSS is the PSD model, which includes three generic steps (Oinas-Kukkonen and Harjumaa 2009): The first step is the analysis of the persuasion context. It includes the consideration of domain-specific issues based on the specific context of use, the users of the BCSS, and the underlying technology. Depending on this analysis, the second step contains an adequate selection of design principles. The PSD model defines 28 different design principles in four categories: primary task support (e.g. self-monitoring, rehearsal), dialog support (e.g. praise, reminders), system credibility support (e.g. trustworthiness, real-world feel), and social support (e.g. competition, normative influence). The final step includes the requirement definition for software qualities and software implementation (Oinas-Kukkonen and Harjumaa 2009).

Self-regulated Learning

There is a variety of established theoretical contributions that address SRL (Panadero et al. 2016). Broadly speaking, "self-regulated students select and use SRL strategies to achieve desired academic outcomes based on feedback about learning effectiveness and skill." (Zimmermann 1990, pp. 6-7). These SRL strategies refer to cognitive and metacognitive learning strategies and strategies addressing resources that are relevant during learning (Pintrich and Groot 1990): Cognitive learning strategies are focused on acquiring new knowledge and storing it in memory. Metacognitive learning strategies enable learners to reflect on their goals and adjust their learning process goal-oriented. Internal resources comprise resources that reside within the learner, while external resources provide additional help (Wild and Schiefele 1994). The following Table 1 presents the learning strategies for SRL.

Superordinate learning strategies	Underlying learning strategies
Cognitive learning strategies	Elaboration; critical thinking; organizing; repeating
Metacognitive learning strategies	Goal setting and planning; monitoring; regulation
Management of internal resources	Effort; attention; time
Management of external resources	Other students; literature; environment

Table 1. Self-regulated Learning Strategies according to Wild and Schiefele (1994)

It is part of LANA to measure students' SRL levels. Therefore, it is crucial to identify an appropriate instrument that a) covers a variety of learning strategies of SRL, b) is appropriate for higher education, and

c) does not discourage students because of its scope or foreign language (students' native language: German). Different assessment procedures have been developed to measure the degree of SRL (Panadero et al. 2016), such as the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al. 1993), or the Learning And Study Strategies Inventory (LASSI) (Weinstein et al. 1987). Wild and Schiefele published a questionnaire in German to measure SRL that is called LIST. Its items are based on the understanding of the MSLQ, capture different facets of SRL, and focus on higher education (Wild and Schiefele 1994). Intending to maintain the breadth of content of the LIST while reducing the likelihood of dropout due to its length Klingsieck (2018) developed a shorter version, called LIST-K that contains 39 items. The LIST-K measures each of the 13 learning strategies listed in Table 1 with 3 items. Thus, the LIST-K can meet the requirements of an instrument for measuring SRL and is therefore integrated into LANA.

Related Work

To draw on the existing knowledge base regarding PT in educational settings, a systematic literature review is conducted. The literature review covers different research areas of BCSSs by including databases with economic, technical, educational, and psychological backgrounds. Eight databases were searched: AISel, Ebscohost, ERIC, IEEE, Pro-quest, PubPsych, Web of Science, and WISO. The underlying search string consists of two parts: The first part addresses the research object BCSS while "persuasive technology" and "persuasive systems" act as synonyms to broaden the search. The second part addresses the relevant application domain of BCSSs, education. The terms "learning*", "education", and "student*" cover this scope. The resulting search string is defined as follows: ("Behavior Change Support System*" OR "Persuasive Technolog*" OR "Persuasive System*") AND (learn* OR education OR student*).

Searching journal and conference articles' titles and abstracts, in total 70 hits were identified, 10 of which were duplicates. Articles addressing other research fields such as health (21), environment (6), or workspace safety (2), intercultural challenges (2), marketing (2), or public events (1) were excluded. Additionally, two articles were excluded because they introduce overarching theoretical models, without implications for educational settings. Four articles did not include students as their focus group and two articles did not address PT. In total 18 articles build the base for the systematic literature review.

The analysis of the identified articles shows that the PSD model is the theoretical background that is dominantly used. However, most researchers design their PT experience-based or based on psychological models without considering the technological components. This is consistent with the findings of the identified literature review by Tikka and Oinas-Kukkonen (2019), who criticize low characterization in terms of the underlying technology and persuasive design in PT research. Although the designed PT is usually not described in detail, the following patterns appear: PT occur mostly in digital learning contexts, addressing online or blended learning. PT are integrated as features in e-learning platforms (Kljun et al. 2019) or massive open online courses (Salim et al. 2019). PT are also incorporated through mobile apps (Sengupta and Williams 2020) or a web app (Orji et al. 2019). Muller et al. (2015) envisioned the potential of wearables, while Goh et al. (2012) pick up persuasion by sending regular SMSs as reminders.

The incentive for researchers to integrate PT into learning contexts is usually students' motivation enhancement (Sengupta and Williams 2020). Six articles even define the success of their intervention by motivation (e.g. Engelbertink et al. 2020; Orji et al. 2019; Lucero et al. 2006). Other goals are the raise of engagement (Kljun et al. 2019), higher involvement and attention (Widyasari et al. 2019), or students' knowledge building (Alvarez et al. 2017). Only four articles address the change of the learning behavior. The identified articles foster the improvement of individual learning strategies for example reflective learning (Muller et al. 2015), knowledge sharing (Wiafe et al. 2020), as well as social-emotional learning, growth mindset, and character development (Williamson 2017). Goh et al. (2012) also envision the potential of PT to foster SRL. Sending persuasive SMS as reminders to students, increased usage of various learning strategies. The evaluation presents a positive impact of SMS interventions on SRL strategies. While Goh et al. (2012) draw on the theoretical background of SRL, the PSD model is not considered. Also, regular SMS interventions do not meet the standard of guiding and assisting students in changing their learning behavior whenever they need support. However, BCSS should meet this claim (Oinas-Kukkonen and Harjumaa 2009).

Filippou et al. (2015a) also noticed the high need for students' support in improving their learning habits. Therefore, their goal was to identify habits that impact academic performance to provide valid information about study behaviors that should be targeted through PT. As learning is a complex process, they concluded

no single habit is responsible for the learning performance. However, study habits related to the management of resources, the value placed by the individual student on learning tasks, and the expectations of learning were identified to be the most impactful (Filippou et al. 2015a). These strategies are also part of the concept of SRL (Pintrich and Groot 1990; Zimmermann 1990). Therefore these findings support the idea of developing a BCSS towards SRL to improve students' learning behavior. In a second step, Filippou et al. (2015b) designed PT as a mobile app that supports students in changing their learning behavior towards scheduling, preparation for class, and group study. The design principles of self-monitoring, suggestions, rewards, and reminders are implicitly addressed. However, an evaluation of the design features is still missing (Filippou et al. 2015b).

Overall, the literature review indicates that PT are well received by students as they are willing to interact with PT and enjoy the integration of technologies into educational environments. The analyzed articles suggest that integrating PT into learning contexts fosters success, such as increased student motivation, greater achievement, or better learning outcomes. Research also proved that PT can change students' behavior. The need for a BCSS to promote aspects of SRL is confirmed in current research. However, research still lacks a clear picture regarding recommendations for specific design principles fostering students' acceptance. While some articles indicate that design principles within the categories of primary task support and social support of the PSD model have a positive effect on students (Boontarig and Srisawatsakul 2020), there is still not sufficient research to understand the underlying modes of action.

Design and Functionality of LANA

Design and Integrated Design Principles

We designed LANA following the PSD model, including the context analysis, the selection of fitting design principles, and the implementation (Oinas-Kukkonen and Harjumaa 2009). To carry out the context analysis, the target users of LANA and their needs are examined: The target users of LANA are university students in general who are trying to meet the demands of digital semesters due to the COVID-19 pandemic. They already have some experience regarding learning, but because of the changing learning environment, they need new impulses or guidance to cope with the new requirements. Therefore, LANA is not intended to address only one target problem or a specific learning strategy, but to show students a variety of ways to improve their learning behavior. Hence, an easily accessible support system with a wide range of learning strategies and a high level of acceptance is required, which accompanies students to achieve sustainable changes in their learning behavior. Smartphone apps can meet these needs. They are quick and easy to use, as they are already firmly integrated into students' daily lives (Ataş and Çelik 2019).

The selection of fitting design principles should be linked to the specific context analysis (Oinas-Kukkonen and Harjumaa 2009). The aim to change learning behavior is complex and the mass of possibilities for improvement is huge (Filippou et al. 2015a). Consequently, students who want to improve their learning behavior face the challenge to identify an effective starting point without losing track or overwhelming themselves. The design principle tunneling is integrated to support students in finding suitable starting points, as tunneling is able "to guide users through a process" (Oinas-Kukkonen and Harjumaa 2009, p. 492). To address tunneling, LANA provides students with the opportunity to compare their desired learning behavior with their current learning behavior. A high difference indicates requirements and opportunities for improvement and provides a starting point for changing the learning behavior. The context analysis also shows that learners need low barriers to use the system, therefore the design principle reduction is integrated to simplify the complex challenge of changing the learning behavior. Reduction is defined as a design principle that breaks down "complex behavior into simple tasks [to help] users perform the target behavior, and it may increase the benefit/cost ratio of a behavior" (Oinas-Kukkonen and Harjumaa 2009, p. 492). LANA integrates reduction by providing step-by-step advice on how to improve SRL strategy usage. Besides, the design principle self-monitoring is integrated, because "a system that keeps track of one's own performance or status supports the user in achieving goals" (Oinas-Kukkonen and Harjumaa 2009, p. 492). LANA enables self-monitoring by ticking off completed tasks. The three integrated design principles are in the category of primary task support and therefore correspond to the findings of the conducted literature review, that support the integration of design principles within this category into PT for education (Boontarig and Srisawatsakul 2020; Filippou et al. 2015b). The following Figure 1 presents the structure of LANA and the integrated design principles.

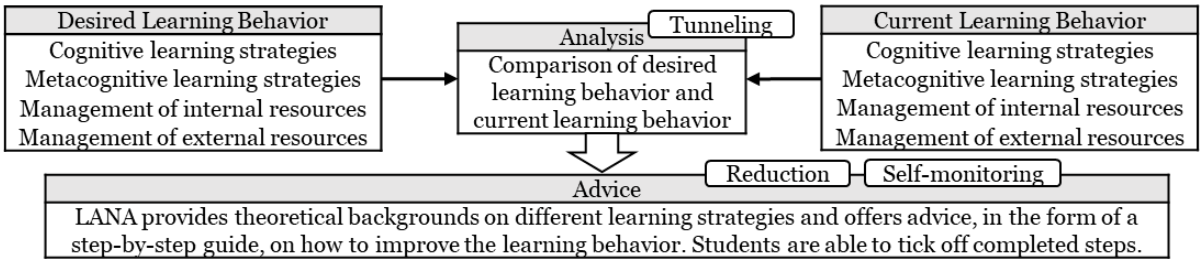

Figure 1. Structure of LANA

Following the PSD model, the final step involves the requirements definition for software qualities and software implementation (Oinas-Kukkonen and Harjumaa 2009). Using the cross-platform development kit Flutter the BCSS is developed as a web app, due to its easy accessibility for the target group, students (Ataş and Çelik 2019).

Functionality and Use Case

LANA is a BCSS that uses the questionnaire LIST-K as a basis for context-sensitive stimulus to action. These impulses in the form of low-threshold steps are adaptively adjustable and offer the possibility to accompany the individual development process of the students as they are suggested based on a repeatable reflection. Ticking off each step visualizes progress, shows students' successes in terms of mastered tasks, and thus paves the way for further SRL implementation. LANA was published in German to German university students. The screens presented in Figure 2 and Figure 3 are translated into English to match the use case explanations.

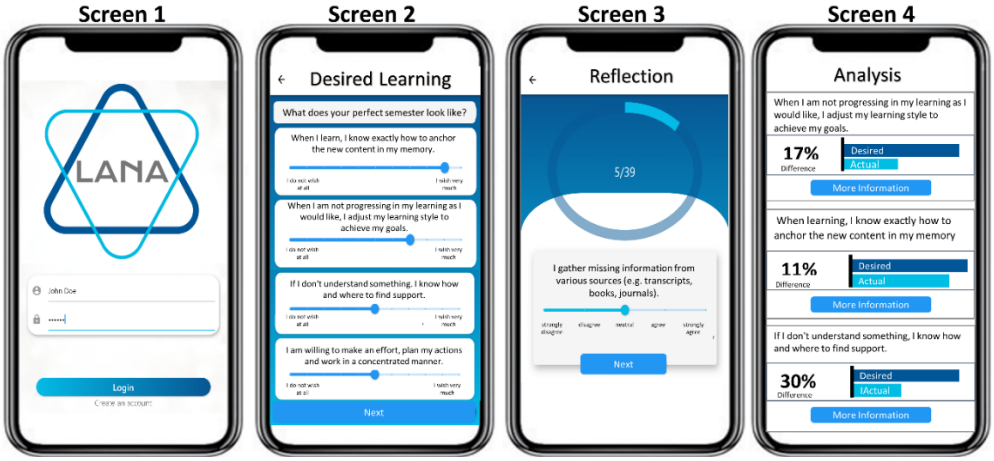

Figure 2. Screenshots of LANA (Screen 1 to 4)

After the sign-in (screen 1), LANA uses four questions to determine the desired learning behavior. Each of these questions refers to one of the four superordinate learning strategies (cognitive, metacognitive, management of internal resources, management of external resources) (see Table 1). To represent the level of desired strategy use, LANA offers a 10-step regulator that ranges from the external point "I do not wish at all" to "I wish very much" (screen 2). By querying the desired learning behavior, students can decide to what extent they want to master different learning strategies. The current level of SRL is measured using the LIST-K with 39 items (screen 3). Based on students' input, LANA then presents the learning analysis. It shows to what extent the desired level of SRL differs from their current learning behavior for each of the four superordinate learning strategies (screen 4), where the value of the superordinate strategies reflects the mean value of the respective underlying strategies according to the structure of the LIST-K (Table 1).

The percentage displayed on the screen indicates where students can begin to improve their learning, with a high value indicating a high potential for improvement. In this case, the metacognitive learning strategy is the superordinate strategy a student wants to improve. By clicking on the button for more information

the student sees to which extend s/he uses the underlying strategies concentration, regulation as well as goal-setting, and planning (screen 5).

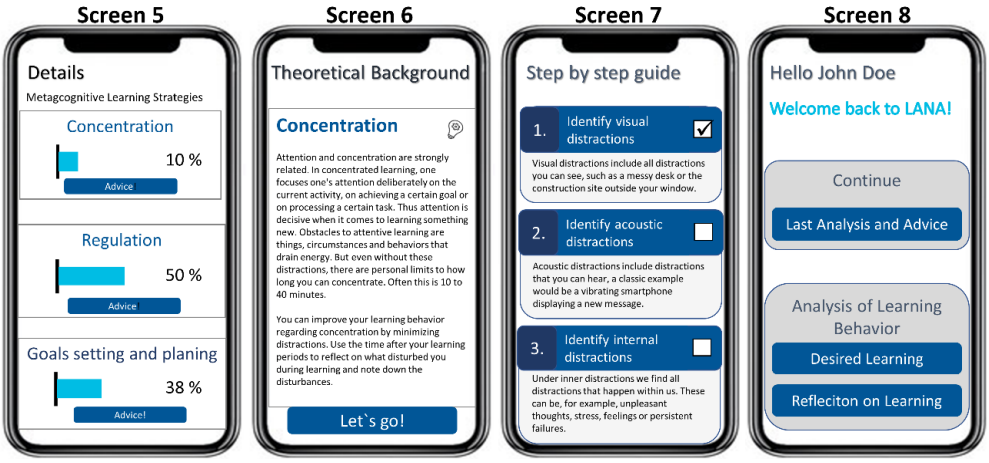

Figure 3. Screenshots of LANA (Screen 5 to 8)

In this example, strategies addressing concentration show a low level of usage (10 %; screen 5), this indicates opportunities for improvement. Clicking on the button "Advice!" LANA provides a theoretical background on that learning strategy, explaining the strategy use and highlighting its importance (screen 6). After presenting this information, LANA offers step-by-step guidance on how to use the strategy more effectively (screen 7). Students can monitor their progress by ticking off the individual steps after completion. This way, students can see which tasks have already been completed and how they can continue to work on their learning behavior. Progress is saved in individual profiles. The next time students open the LANA, the home screen presents the following options (screen 8): First, students can continue to work on specific learning strategies. To do so, they open their last learning analysis and see the difference between their desired and current learning behavior. Based on this visualization, they will get adequate advice on how to improve their learning behavior step by step. Second, students can also repeat the reflection on their desired learning behavior. Third, there is also an opportunity to reflect on the current learning behavior to identify differences. By repeating the reflection LANA adaptively adjust the recommendation for starting points and thus considers the individual development process of its users.

Evaluation and Results

LANA is the first prototype in a larger research project developing a BCSS towards SRL. The goal of the evaluation in the early stages is to reveal problems and quickly identify opportunities for improvement. In this way, new findings can be integrated at short notice and the prototype can be further developed in an iterative process (Hevner et al. 2004; Hevner 2007). To identify crucial design features that affect the acceptance and IU of LANA, an evaluation with quantitative and qualitative data is fitting (Davis 1986).

The evaluation took place in the last session of a semester-long course addressing key qualifications at a German university. This course is mandatory in the first semester for the students of Business and Information Systems Engineering at their university. At the end of the last session, students could decide whether to leave the session early or to stay additional 20 minutes to test LANA. After the testing phase, a questionnaire was then used to collect evaluation data. To identify constructs influencing IU, perceived usefulness (PU), perceived ease of use (PEU) and IU, were measured with items defined within the TAM (Davis 1986). The questionnaire also includes two open-ended questions that provide an opportunity to add individual thoughts: First, what do students like about their experience using LANA? Second, what are possible improvements for LANA?

In total 24 students were given access to LANA. 20 students created an account and spent 20 minutes interacting with LANA. Out of these 20 students, 18 also completed the subsequently shared questionnaire. Since 18 of the 24 students participated in the evaluation of LANA, this results in a response rate of 75%. Students were on average 20.6 years old, with the youngest being 18 and the oldest 22 years old. 28 percent of the respondents were female and 72 percent were male.

After the verification of the preconditions, the TAM was analyzed conducting a multiple linear regression analysis to see to which extend PU and PEU affect IU (Figure 4). Items used to measure PU, PEU, and IU showed overall good measurement characteristics (with Cronbach's α ranging from .76 to .84). The multiple linear regression analysis shows that the R^2 for the overall model is .85 (adjusted R^2=.83), indicating high goodness of fit (Cohen 1988). As a result, PU is identified with a significant positive influence on IU. PEU has no significant influence on IU. However, since the importance of PEU is still emphasized in the literature, this study also addresses design features that might affect PEU.

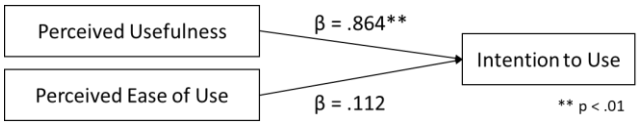

Figure 4. Regression Analysis of TAM regarding LANA

Coding of qualitative responses was conducted to identify patterns related to students' insights about how a BCSS towards SRL should be designed to foster acceptance. The identified features were mapped to PU or PEU. Table 2 presents these design features that might have a positive influence on IU as well as possible improvements. Because the detailed student responses in some cases address more than one design feature, the total number of mentioned design features is higher than the number of students responding.

Positive	TAM	#	Improvement	TAM	#
Simple user interface design	PEU	6	User interface design of log-in screen	PEU	3
Design principle reduction	PU	3	Usability	PEU	3
Design principle self-monitoring	PU	3	Fewer reflection questions	PU	3
Content especially advice	PU	3	Downloadable mobile app	PEU	1
Questions for reflection	PU	3	More interaction	PEU	1
Usability and clear structure	PEU	3	More youthful language	PEU	1
Analysis and comparison	PU	1	More advice	PU	1
Web app for mobile usage	PEU	1			

Table 2. Design Features influencing Intention to Use LANA

The analysis of the qualitative data shows that the design of BCSSs seems to be particularly important. The user interface (UI) design is the most frequently mentioned feature in both categories. While six students indicate that they like the simple UI design, the UI design is also the most frequently mentioned area for possible improvement, in particular the login screen. Students also described design principles based on the PSD model in their responses. They liked the design principle reduction, as they value its function to cut down a complex task into smaller steps. Self-monitoring is also a design principle that students like. Students highlight the importance of the content addressing SRL, stating that advice on how to improve or use learning strategies is a relevant subject for them. Three students also note that they like the questions that guide through reflecting on the current learning behavior by asking about different aspects of learning strategies. The followed analysis that relates to current learning behavior is also a feature that is noted positively. One student also likes the fact that s/he can use the BCSS in a mobile and flexible way.

In terms of improvement, besides the UI design specifications, usability is a high requirement. Since the web app LANA is programmed from scratch, some bugs and unexpected errors still occurred during its use, which three students noticed negatively. Three students also disliked the long reflection period. They would prefer to receive practical advice more quickly. Other improvements include a mobile app that can be downloaded from an app store, increased interaction, a more youthful language, and additional advice.

Discussion

The students share an overall positive attitude towards their experience with LANA. Regarding the TAM, only PU is identified with a significant influence on students' IU. The reason for this might be the high relevance of good learning behavior in students' current stage of life. Accordingly, when deciding on the use of LANA, the focus is strongly on PU. The qualitative responses indicate the same, as students value the content of LANA, especially the tangible advice as well as the guided reflection of the learning behavior. The most prominent design features in the category PU are the design principles reduction and self-monitoring.

While students positively described these two design principles, the third integrated design principle tunneling was not noticed. The reason for this might be, that students were able to actively experience reduction and self-monitoring, while tunneling would rather be noticed when missing. Without tunneling, students would not get a recommendation on where to start their improvement of the learning behavior.

Although PEU was found to have no significant impact on IU, the qualitative data suggest that PEU is still important regarding the design of BCSSs for students. Students reported very different user experiences after their interaction with LANA. While some students positively highlight the perceived clear structure and the usability, others criticize occurring bugs, and the lengthy reflection phase. Overall, the UI design is the feature students addressed the most and seems to be important when developing BCSSs for students. Therefore, it is crucial to address content, relevant to students and present it in a clear and structured way.

Conclusion and Outlook to Future Research

This study presents LANA, a BCSS towards SRL designed following the PSD model. The goal of the BCSS is to support students, particularly in digital learning environments caused by the COVID-19 pandemic, by giving advice on how to improve students' learning. The study evaluates the BCSS LANA regarding the users' initial acceptance, as a first, necessary evaluation of newly implemented technologies. It provides a descriptive and pragmatic contribution by presenting researchers and developers of BCSSs in educational contexts implications based on the current state of the art, and a description of a BCSS towards SRL as an example implementation. The findings of the conducted literature review, as well as the evaluation of LANA, support the integration of PT in higher education, because students, in general, enjoy the interaction with these systems. The observation that of the 24 students who had access to LANA, 20 initially created an account, and 18 became more intensively involved with the BCSS indicates a high initial IU the system. As only PU is identified with a significant influence on IU, it is crucial for students to notice the benefits and relevance of BCSSs. LANA is able to fulfill this requirement by addressing the topic SRL and by presenting tangible advice, that students can easily integrate into their current learning settings. The results also show that design features regarding UI design are the most frequently addressed features in the qualitative evaluation. Although they are not identified with a significant impact on students' IU, the frequency with which they are mentioned indicates that UI design is important to students and could influence their interaction with the system, such as long-term use or liking the BCSS.

The presented study has some limitations. First, the evaluation of LANA was conducted with a limited number of 18 participants. An evaluation within a larger group could identify additional design features. But since the participants exactly represent the target users of the BCSS LANA, the insights and feedback of these students are valuable and provide a meaningful contribution. Second, an analysis of the qualitative data is subjective. However, the manual coding involves the differentiation between two defined categories (PU and PEU), and the matching of the design features is presented transparently in Table 2, which narrows the scope for misinterpretation. Third, LANA has not yet been evaluated with respect to its goal of promoting SLR. However, BCSSs are only able to change the behavior sufficiently when an underlying acceptance is present. Therefore, it is an essential first step to identify design features that can increase students' IU in the early stages of development. These early evaluations are important because they provide early indications of underlying improvements, and misleading assumptions are quickly uncovered before they are built upon for too long. In this way, the prototype can be gradually improved in an iterative process (Hevner et al. 2004).

Our next steps in the development project for a BCSS towards SRL include fixing identified bugs. New features will be integrated to address the different preferences of users: There will be an opportunity to choose whether to begin with a reflection on current learning behavior or to directly access the advice. To address the desire for a more youthful language, the text-based theoretical background will be replaced with short video elements. The new prototype will be evaluated next winter with more participants. To avoid bugs, more comprehensive quality checks will be performed before the release of LANA 2.0.

Overall, the study supports that the development and evaluation of BCSSs towards better learning behavior for students should be part of future research. BCSSs can serve as a valuable supplement to digitized courses, provide necessary learning skills, and help students to cope with the impact of COVID-19 measures addressing higher education.

References

Allan, J. L., Johnston, M., and Campbell, N. 2008. "Why do people fail to turn good intentions into action? The role of executive control processes in the translation of healthy eating intentions into action in young Scottish adults," *BMC public health* (8), p. 123.

Alvarez, A. G., Dal Sasso, G. T. M., and Iyengar, M. S. 2017. "Persuasive technology in teaching acute pain assessment in nursing: Results in learning based on pre and post-testing," *Nurse education today* (50), pp. 109-114.

Ataş, A. H., and Çelik, B. 2019. "Smartphone Use of University Students: Patterns, Purposes, and Situations," *Malaysian Online Journal of Educational Technology* (7:2), pp. 54-70.

Boontarig, W., and Srisawatsakul, C. 2020. "A Framework for Designing and Evaluating Persuasive Technology in Education," in *Recent Advances in Information and Communication Technology 2020*, P. Meesad and S. Sodsee (eds.), Cham: Springer International Publishing, pp. 93-103.

Brown, J. S. L. 2018. "Student mental health: some answers and more questions," *Journal of mental health* (27:3), pp. 193-196.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*, New York: Lawrence Erlbaum Associates.

Davis, F. D. 1986. *A Technology Acceptance Model for Empirically Testing new Enduser Information Systems*, Cambridge.

Eisenberg, D., Speer, N., and Hunt, J. B. 2012. "Attitudes and beliefs about treatment among college students with untreated mental health problems," *Psychiatric services (Washington, D.C.)* (63:7), pp. 711-713.

Engelbertink, M. M. J., Kelders, S. M., Woudt-Mittendorff, K. M., and Westerhof, G. J. 2020. "Evaluating the value of persuasive technology and the role of teachers in a blended learning course for social work students," *Social Work Education* (1:2), pp. 1-17.

Filippou, J., Cheong, C., and Cheong, F. 2015a. "Combining the Fogg Behavioural Model and Hook model to Design features in a Persuasive App to Improve Study Habbits," in *Australasian Conference on Information Systems*, F. Burstein, H. Scheepers and G. Deegan (eds.), Adelaide, Australia. 30.11-04.12.2015, p. 74.

Filippou, J., Cheong, C., and Cheong, F. 2015b. "Designing Persuasive Systems to Influence Learning: Modelling the Impact of Study Habits on Academic Performance," in *Proceedings of the 19th Pacific Asia Conference on Information Systems*, A. Kankanhalli, A. B. Jones, Teo and Thompson (eds.), Singapore , Singapore. 05.07-09.07.2015, p. 156.

Fogg, B. J. 2003. *Persuasive Technology*: *Using Computers to Change What We Think and Do*, San Francisco: Morgan Kaufmann Publishers.

Goh, T.-T., Seet, B.-C., and Chen, N.-S. 2012. "The impact of persuasive SMS on students' self-regulated learning," *British Journal of Educational Technology* (43:4), pp. 624-640.

Hevner, A. R. 2007. "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems* (19:2), pp. 87-92.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in IS Research," *Management Information Systems Quarterly* (28:1), pp. 75-105.

Kim, H.-C. 2015. "Acceptability Engineering: The Study of User Acceptance of Innovative Technologies," *Journal of Applied Research and Technology* (13), pp. 230-237.

Kljun, M., Krulec, R., Pucihar, K. C., and Solina, F. 2019. "Persuasive Technologies in m-Learning for Training Professionals: How to Keep Learners Engaged With Adaptive Triggering," *IEEE Transactions on Learning Technologies* (12:3), pp. 370-383.

La Fuente, J. de, Peralta-Sánchez, F. J., Martínez-Vicente, J. M., Sander, P., Garzón-Umerenkova, A., and Zapata, L. 2020. "Effects of Self-Regulation vs. External Regulation on the Factors and Symptoms of Academic Stress in Undergraduate Students," *Frontiers in psychology* (11), p. 1773.

LeViness, P., Gorman, K., Braun, L., Koenig, L., and Bershad, C. 2019. "The Association for University and College Counseling Center Directors: Annual Survey: 2019," Association for Univeristy and College Counseling Center Directors (ed.).

Lucero, A., Zuloaga, R., Mota, S., and Muñoz, F. 2006. "Persuasive Technologies in Education: Improving Motivation to Read and Write for Children," in *Persuasive Technology*: *First International Conference on Persuasive Technology for Human Well-Being*, W. IJsselsteijn, Y. de Kort, C. Midden, B. Eggen and E. van den Hoven (eds.), Eindhoven. 18.05.2006-19.05.2006, pp. 143-153.

Muller, L., Divitini, M., Mora, S., Rivera-Pelayo, V., and Stork, W. 2015. "Context Becomes Content: Sensor Data for Computer-Supported Reflective Learning," *IEEE Transactions on Learning Technologies* (8:1), pp. 111-123.
Oinas-Kukkonen, H. 2013. "A foundation for the study of behavior change support systems," *Personal and Ubiquitous Computing* (17:6), pp. 1223-1235.
Oinas-Kukkonen, H., and Harjumaa, M. 2009. "Persuasive Systems Design: Key Issues, Process Model, and System Features," *Communications of the Association for Information Systems* (24).
Orji, F. A., Oyibo, K., Greer, J., and Vassileva, J. 2019. "Drivers of Competitive Behavior in Persuasive Technology in Education," in *Adjunct Publication of the 27th Conference on User Modeling, Adaptation and Personalization - UMAP'19 Adjunct*, G. A. Papadopoulos, G. Samaras, S. Weibelzahl, D. Jannach and O. C. Santos (eds.), Larnaca, Cyprus. 09.06.2019 - 12.06.2019, New York, New York, USA: ACM Press, pp. 127-134.
Panadero, E., Klug, J., and Järvelä, S. 2016. "Third wave of measurement in the self-regulated learning field: when measurement and intervention come hand in hand," *Scandinavian Journal of Educational Research* (60:6), pp. 723-735.
Pintrich, P. R., and Groot, E. V. de 1990. "Motivational and Self-Regulated Learning Components of Classroom Academic Performance," *Journal of Educational Psychology* (82:1), pp. 33-40.
Pintrich, P. R., Smith, D. A., Gracia, T., and McKeachie, W. J. 1993. "Reliability and Predictive Validity of the Motivated Strategies for Learning Questionarie," *Educational and Psychological Measurement* (53), pp. 801-813.
Salim, M. H. M., Mohamad, N., and Taha, M. 2019. "Understanding Students' Motivation and Learning Strategies to Redesign Massive Open Online Courses based on Persuasive System Development," *International Journal of Advanced Computer Science and Applications* (10:12), p. 234.
Sengupta, A., and Williams, S. 2020. "Can an Engagement Platform Persuade Students to Stay? Applying Behavioral Models for Retention," *International Journal of Human–Computer Interaction* (24:10).
Stolzenburg, S., Freitag, S., Evans-Lacko, S., Speerforck, S., Schmidt, S., and Schomerus, G. 2019. "Individuals with currently untreated mental illness: causal beliefs and readiness to seek help," *Epidemiology and psychiatric sciences*, pp. 446-457.
Teri, S., Acai, A., Griffith, D., Mahmoud, Q., Ma, D. W. L., and Newton, G. 2014. "Student use and pedagogical impact of a mobile learning application," *Biochemistry and molecular biology education : a bimonthly publication of the International Union of Biochemistry and Molecular Biology* (42:2), pp. 121-135.
Tikka, P., and Oinas-Kukkonen, H. 2019. "Tailoring persuasive technology: A systematic review of literature of self-schema theory and transformative learning theory in persuasive technology context," *Cyberpsychology: Journal of Psychosocial Research on Cyberspace* (13:3).
van Wyk, M. 2017. "Exploring Student Teachers' Views on ePortfolios as an Empowering Tool to Enhance Self-Directed Learning in an Online Teacher Education Course," *Australian Journal of Teacher Education* (42:6), pp. 1-21.
Weinstein, C. E., Palmer, D., and Schulte, A. C. 1987. *Learning and study strategies inventory (LASSI)*, Clearwater: H & H Publishing.
Wesselborg, B. 2020. "Enhancing of self-regulated learning strategies for health care students to improve e-learning in the "Corona semester" as an interdisciplinary task," *GMS journal for medical education* (37:7), 76.
Wiafe, I., Koranteng, F. N., Owusu, E., Ekpezu, A. O., and Gyamfi, S. A. 2020. "Persuasive social features that promote knowledge sharing among tertiary students on social networking sites: An empirical study," *Journal of Computer Assisted Learning* (36:5), pp. 636-645.
Widyasari, Y. D. L., Nugroho, L. E., and Permanasari, A. E. 2019. "Persuasive technology for enhanced learning behavior in higher education," *International Journal of Educational Technology in Higher Education* (16:1), p. 743.
Wild, K.-P., and Schiefele, U. 1994. "Lernstrategien im Studium: Ergebnisse zur Faktorenstruktur und Reliabilität eines neuen Fragebogens," *Zeitschrift für Differentielle und Diagnostische Psychologie* (15), pp. 185-200.
Williamson, B. 2017. "Decoding ClassDojo: psycho-policy, social-emotional learning and persuasive educational technologies," *Learning, Media and Technology* (42:4), pp. 440-453.
Zimmermann, B. J. 1990. "Self-Regulated Learning and Academic Achievement: An Overview," *Educational Psychologist* (25:1), pp. 3-17.