Design considerations for a mobile sensor-based learning companion

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Abstract. This paper presents the concept of a mobile learning companion which uses sensor data to support self-regulated learning. Based on design considerations derived from previous work, a prototype of a mobile learning companion (Charlie) was developed as a student project at HTW Berlin. A first qualitative study with 4 students aimed at validating Charlie's character as a friendly learning companion and its benefits and limitations for self-regulated learning. Future work will focus on improving Charlie to provide a positive learning support as a mobile learning companion.

Keywords: mobile learning · sensor-based learning · learning companion · self-regulated learning · pedagogical agent

1 Introduction

Various research shows that self-regulated learning strategies can help students to cope with cognitively, emotionally and behaviourally challenging situations, and lead to academic achievements [15]. Corno[5] discussed that external support (by teachers or computers) can help learners to modify their cognitive, motivational and behavioural states. Even de-contextualized responses from a computer can support learners for positive learning achievements. Referring to various training programs and systems, Azevedo and Cromley [1] explored the advantages of a learning companion as a way to support self-regulated learning in an online-learning environment. In this paper, we present our conceptual work on using a mobile device with integrated sensors (e.g. camera, heart rate, proximity sensor, and microphone) for a context-aware self-regulated learning agent, named Charlie. Then we present a prototypical realisation of Charlie and report preliminary findings.

2 Sensor-based Learning Companion for Self-Regulated Learning

To be self-regulated learners, students should be aware of their responsibility to engage, learn and reflect on their learning, and they should be equipped

with these core skills [12]. However, learners are limited in exerting their competency in self-regulation, because they cannot see the effects of self-regulation on their learning achievements, and because they are not convinced whether they could enact appropriate self-regulated strategies [15]. In addition, learners may lack motivation and interest in their learning tasks and feel no necessities to put self-regulation into action. Zimmerman and colleagues [15] suggested various methods to enforce and motivate learners' engagement in self-regulated learning. Operant views of self-regulated learning include external nudges (e.g. teachers' questions or alerts from a system) as methods to promote self-regulated learning, whereas phenomenological views of self-regulated learning emphasise the increase of self-awareness including planning, goal setting, monitoring, and evaluation of learners. Furthermore, not only the environmental and behavioural factors but also learners' cognitive and affective processes are advised under social cognitive views of self-regulated learning. Comprehensively, to support learners to be more self-regulated in their learning, both learner's internal (e.g. cognition, motivation, emotion) and external (e.g. environment and behaviours) conditions should be considered. In an informal learning environment, learning takes place in various locations (external condition), and the learning process and management are mainly controlled by learners (internal conditions). In this setting, a mobile device with integrated sensors is appropriate to support self-regulated learning phases and stages. Specifically, conditions of the learning environment (e.g. brightness, noise level) can be attained by sensors such as microphone and camera. In addition, GPS and WIFI can seamlessly locate learners' location [11]. This information can help learners critically evaluate their physical learning environment with respect to their learning goals and achievement.

3 Charlie, a mobile sensor-based learning companion

Based on suggestions from [14], for the design of a sensor-based learning companion, a smartphone app (Charlie) was designed, and a first prototype of Charlie was implemented. Similar to [10], a neutral name was chosen, so Charlie can be seen both as a female and male character.

Designing a first prototype of Charlie, six design considerations were considered: 1) correspondence to learner's characteristics, 2) instructional advantages and encouragement, 3) initiation of dialogue ad engagement to reflect, 4) a simple and stylish visual with task and relation orientation, 5) a fellow learner and a real human, and 6) positive interaction and positive perception of overall learning experience. Charlie engages learners to set clear learning goals according to learning tasks of their choice by using the SMART goal model as proposed by [9]. Upon setting a goal, Charlie asks the learner to set a place and the expected time necessary to complete the goal. By setting a goal and the expected study duration, Charlie engages the learner to be aware of importance of specific goals which needs to be specific, measurable, attainable, realistic and time-bound. When a learner is ready to proceed learning, Charlie accompanies the learner by 1) showing the user-defined goal and place, 2) giving ambient information

such as brightness and noise level, 3) informing about progress as time-lapse, 4) giving feedback and recommendations on demand.

To appear as a human-like peer, Charlie uses Emoji which has facial expression. Colours and messages were designed based on three design considerations of a learning companion: 1) a simple stylish visual [2] [4], 2) encouragement-oriented and relation-oriented messages [13] and 3) fellow learner-human [6]. Empathetic feedback was supported by the use of affective colours [3]. For messages, three areas of volitional control strategies [8] (self-efficacy enhancement, stress reducing actions, negative based incentives) were adopted. Additionally, learning related humours and quotes have been chosen from online resources to improve human characteristics. In a student's project at HTW Berlin, a Charlie prototype was implemented as an Android app to gain learners' perception of a mobile sensor-based learning companion.

4 Results

Based on the first development of Charlie, four students at HTW Berlin volunteered to participate in interacting with Charlie and engage in open-ended interviews. When interacting with Charlie, learners expressed a positive impression toward the relation-oriented messages, in addition to being interested in the concept behind it. Yet, learners spoke up for more active involvement and clear indication of its extend of competence.

Overall, related to Charlie being a fellow learner/human, participants liked the default name, Charlie. In addition, participants stated that they had a personal feeling which was due to the look of Charlie. Regarding on a goal setting, learners felt **a bit forced** when writing their goals, because all the fields such as learning action, learning field, learning objective were mandatory. Interestingly, all participants claimed that they are well aware of how to set a goal, yet without assistance, goal setting was neither clear to them nor easy. Additionally, all participants liked the visualisation of their learning session and found the recommendations helpful. Regarding on the learning time, one participant was curious whether a companion will give him/her information when he/or she is **productive**.

5 Discussion & Outlook

Considering the availability of mobile devices like smartphones and their integrated sensor technology, the information that the device provides for learners can improve self-awareness of learning. The paper presents the theoretical background, idea, development and evaluation of Charlie as a mobile learning companion to support self-regulated learning. The learners' comments were analysed by conducting a qualitative research to reflect their impression when interacting with Charlie as a learning companion. Due to the low sample size, the results can not be generalised, yet comments from actual learners who have interacted

with Charlie allowed us to reflect on future steps to improve a mobile sensor based learning companion.

References

1. Azevedo, R., Cromley, J.G.: Does training on self-regulated learning facilitate students' learning with hypermedia? Journal of educational psychology **96**(3), 523 (2004)
2. Bartneck, C., Reichenbach, J., Breemen, v.A.: In your face, robot! the influence of a character's embodiment on how users perceive its emotional expressions. In: Proceedings of the Design and Emotion. pp. 32–51. Ankara Turkey (2004)
3. Bartram, L., Patra, A., Stone, M.: Affective color in visualization. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. pp. 1364–1374. ACM (2017)
4. Cercone, K.: Characteristics of adult learners with implications for online learning design. AACE journal **16**(2), 137–159 (2008)
5. Corno, L.: Self-regulated learning: A volitional analysis. In: Self-regulated learning and academic achievement, pp. 111–141. Springer (1989)
6. Gulz, A., Haake, M.: Virtual pedagogical agents–design guidelines regarding visual appearance and pedagogical roles. Current Developments in Technology-Assisted Education,© FORMATEX 2006 (2006)
7. Keppell, M.: Personalised learning strategies for higher education. In: The future of learning and teaching in next generation learning spaces, pp. 3–21. Emerald Group Publishing Limited (2014)
8. McCann, E.J., Garcia, T.: Maintaining motivation and regulating emotion: Measuring individual differences in academic volitional strategies. Learning and individual differences **11**(3), 259–279 (1999)
9. Robins, E.M.: An instructional approach to writing smart goals (2014)
10. Ryokai, K., Vaucelle, C., Cassell, J.: Virtual peers as partners in storytelling and literacy learning. Journal of computer assisted learning **19**(2), 195–208 (2003)
11. Schmidt, A., Aidoo, K.A., Takaluoma, A., Tuomela, U., Van Laerhoven, K., Van de Velde, W.: Advanced interaction in context. In: International Symposium on Handheld and Ubiquitous Computing. pp. 89–101. Springer (1999)
12. Terras, M.M., Ramsay, J.: Massive open online courses (moocs): Insights and challenges from a psychological perspective. British Journal of Educational Technology **46**(3), 472–487 (2015)
13. Woolf, B.P.: Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning. Morgan Kaufmann (2010)
14. Yun, H., Fortenbacher, A., Pinkwart, N.: Improving a mobile learning companion for self-regulated learning using sensors. In: CSEDU (1). pp. 531–536 (2017)
15. Zimmerman, B.J., Schunk, D.H.: Self-regulated learning and academic achievement: Theory, research, and practice. Springer Science & Business Media (2012)