Making Information Literacy Instruction more efficient by providing individual Feedback

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This is an Accepted Manuscript of an article published by Taylor & Francis in Studies in Higher Education on 17 Sep 2015, available online: http://www.tandfonline.com/doi/full/10.1080/03075079.2015.1079607.

Citation of the published article:
Peter, J., Leichner, N., Mayer, A.-K., & Krampen, G. (2015). Making information literacy instruction more efficient by providing individual feedback. *Studies in Higher Education*. Advance online publication. doi:10.1080/03075079.2015.1079607

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This paper presents an approach to information literacy instruction in colleges and universities that combines online and classroom learning (Blended Learning). The concept includes only one classroom seminar, so the approach presented here can replace existing one-shot sessions at colleges and universities without changes to the current workflow. By adding online materials to a classroom seminar, comprehensive information literacy instruction can be delivered in a time-efficient way. To make instruction more time efficient, each student received individual recommendations which of the online materials he/she is supposed to complete based on a pre-test. Results of an evaluation study with 64 psychology students point to significant increases of information literacy and indicate that most students accepted and followed the recommendations. The findings also show that students who completed materials beyond the recommendations did not show a greater learning progress than those following the recommendations closely emphasizing the adequacy of the recommendations provided.

Keywords: word; another word; lower case except names

Background

'Information literacy' is used as an umbrella term for a set of skills which are necessary to identify, access, evaluate, and use information effectively (Grassian and Kaplowitz 2009, 8). Issues about fostering information literacy are discussed especially frequently among lecturers and librarians in higher education because skills related to information literacy are proposed to play a crucial role in the self-regulated acquisition of knowledge (Joo, Bong, and Choi 2000). With regard to teaching psychology, the 'American Psychological Association' (APA) likewise emphasizes the importance of fostering information literacy skills, as they are essential for college students' ability to engage in scientific inquiry (American Psychological Association 2013). Despite the importance of information literacy, several studies show that students in higher education frequently lack these skills (e.g. Smith et al. 2013) or point to deficits in information literacy instruction efforts (Johnston and Webber 2003). For example, Head and Eisenberg (2009) report that college students' strategies to gather information are

rarely elaborate and mostly not adapted to the characteristics of the information problems they are confronted with. As a consequence, fostering students' information literacy in higher education appears to be indispensable.

Despite this emphasis on the importance of information literacy instruction, the vast majority of it seems to be one-shot-sessions delivered by a librarian and integrated into an existing subject-related course (e.g. a psychology course) (Fister and Eland 2008). A one-shot session is not enough to cover information literacy comprehensively (Grassian and Kaplowitz 2009; Mery, Newby, and Peng 2012), so it can be assumed that a lot of informal learning takes place through experiencing information problems in practice. Research has shown that students mostly stick to information-seeking strategies already known to them instead of conducting comprehensive literature searches comparing several strategies (Head and Eisenberg 2010). Therefore, we cannot expect students to have a uniform level of knowledge when it comes to finding scholarly information. Instead, students will have individual strengths and weaknesses concerning information seeking strategies. For example, those students who tend to use a bibliographic database like PsycINFO™ when conducting a literature search will have extensive knowledge about this resource (and bibliographic databases in general), while other students have a great deal of experience with the use of Google Scholar™, but lack knowledge of bibliographic databases.

This situation leads to two challenges for information literacy instruction programs. First, instruction has to be delivered in a time-efficient manner, as little time is devoted to information literacy at colleges and universities. Second, as we expect strengths and weaknesses concerning students' information-seeking strategies to differ between individuals, instruction programs should be designed in such a way as to deal with this kind of fragmented knowledge among the participants. One way to face these

challenges is to adjust training materials individually to previous knowledge using a remedial strategy (cf Carrier and Jonassen 1988) that is to provide additional instruction for learners deficient in a particular field. This allows dealing with fragmented prior knowledge as learners can tackle their individual knowledge gaps. At the same time, instruction is delivered in a very time-efficient manner as participants selectively work on individual deficits instead of completing all materials available. Computer-based learning is especially suitable for individually adapted instruction as learning occurs individually (Carrier and Jonassen 1988; Park and Lee 2003). Furthermore, computer-based instruction, in itself, allows time flexibility (Bowers and Kumar 2015).

The aim of this paper is to present an approach to information literacy instruction developed by a research project at the Leibniz Institute for Psychology Information in Trier, Germany. The concept comprises a combination of online learning and one classroom seminar (Blended Learning, cf Garrison and Kanuka 2004). The majority of the content is supposed to be imparted by the online materials, while the classroom seminar should mainly serve to reflect the online materials and to practice.

To deal with the challenges mentioned above, the online materials are designed in an adaptable fashion: The participants are required to complete a pre-test. Then recommendations are provided concerning which part of the online materials should be completed to selectively fill knowledge gaps. In the following, we present the conceptual background for the adaptation of instruction and report results and lessons learned from the implementation of an instruction program which was designed in this fashion.

Adapting materials to individual differences

Considerations about adapting instruction to individual differences have a long history dating back to BC (Park and Lee 2003). Psychological research concerning this

topic has gained ground since Cronbach (1957) argued that interactions between individual characteristics and treatment variables receive too little attention. Previous efforts to set up individualized instruction have identified two dimensions on which such efforts can be classified. The first dimension refers to the way of matching individual characteristics and instruction (Carrier and Jonassen 1988). The second dimension refers to the way instruction is offered (e.g. Leutner 2004).

Concerning the first dimension, four types of matches between individual characteristics and instruction have been identified by Carrier and Jonassen (1988) whose work is based on a taxonomy developed by Salomon (1972). The first way, called remedial strategy (1), implies that supplementary instruction is provided to learners who show deficiencies in a certain field. An example from the current context would be a student who is adept at using bibliographic databases, but shows deficits when using Google Scholar™, or the library catalogue. Thus, this student would be offered additional instruction on how to use Google Scholar™ and the library catalogue. If a capitalization strategy (2) is employed, material is matched in a way that it is consistent with the learner's preferences. For example, a student who prefers visual presentation of materials would be provided materials that convey the relevant information using graphical representations. A compensatory strategy (3) means the use of teaching techniques that supplant those requirements in which the learner is deficient. This strategy can be used if a remedial strategy is not applicable. For example, students who have difficulties in reading are provided teaching videos. A challenge strategy (4) requires the learner to develop new skills (e.g. a student is given a literature search task which can only be solved by using bibliographic databases, so the student has to learn how to use this resource).

Concerning the second dimension, two approaches to offer individualized instruction can be found in the literature. In the case of adaptive instruction (1), teaching is individualized by the instructor based on the information available about the learner. In that case, the materials are presented to the learner in the way that is most appropriate for him according to the adapting procedure. When instruction is provided online, the teaching is automatically adapted by the electronic system based on information about the learner (e.g. age, or the choices which the learner made when interacting with the system). When adaptable instruction (2) is employed, the learner can choose the materials and/or instructional methods. In the case of online instruction, the learner is given control over the electronic system, so he can choose the materials, or the instructional method, or both (Cristea and Bra 2002; Leutner 2004; Park and Lee 2008).

Studies examining the effectiveness of adaptive teaching approaches, however, have reported mixed results. This is probably due to the fact that the individual characteristics (e.g. age, skill level) used for adapting content were not selected appropriately (Park and Lee 2003, 2008). The use of adaptable systems is suggested as a viable alternative (Snow 1980). Giving the learner control over the learning materials also has motivational benefits (Brophy 2010). The effectiveness of conditions that permit learner control can be enhanced by giving recommendations, especially when learners have little previous knowledge (Brophy 2010; Kanar and Bell 2013). There is indication that especially less advanced learners benefit from recommendations (Shin, Schallert, and Savenye 1994). Giving recommendations seems to be especially relevant in information literacy instruction as many students know too little about the field to make appropriate decisions without support (Grassian and Kaplowitz 2009). Examples for the successful implementations of adaptable designs in different contexts are provided by Chang et al. (2015) who present a learning system that offers individual

recommendations based on participants working memory capacity, or Kim et al. (2014) who were able to show that using a adaptable online learning system enhances self-directed learning skills compared to a control group which did not use an adaptable learning system.

Design of the instruction program

Research on student information seeking behavior has shown that most students use bibliographic databases only after being informed about this resource during library instruction (Head and Eisenberg 2009). Moreover, even graduate students often possess insufficient knowledge about advanced search strategies like the use of Boolean operators or truncation (Catalano 2013, 267). Finally, students often turn to the internet for initial research (Catalano 2013) and experience problems when filtering out irrelevant information (Head and Eisenberg 2011).

Consequently, the major section of the online materials was dedicated to the use of the most important information resources for psychology students (the bibliographic databases PsycINFO™ and PSYNDEX™, but also Google Scholar™) and the advantages and disadvantages of these resources. Additionally, the online materials also included other content related to finding, accessing and evaluating information in an academic context, so the content of the instruction program was aligned with the psychology specific information literacy standards (Association of College and Research Libraries (ACRL) 2010).

As mentioned above, the instruction program combined online and classroom teaching (Blended Learning, cf Garrison and Kanuka 2004). Most of the content was imparted by the online materials, which consisted of eight chapters. So the classroom seminar could be limited to a single session taking around three hours. The classroom seminar took place after the completion of the online materials. The major purpose of it

was to give the students the opportunity to apply the newly learned skills when finding information about topics from the field of psychology. Therefore, the longest time block contained individual literature searches concerning psychology related research topics. The instructors were available to support the participants if they encountered problems during their literature searches. To make this task more relevant for the participants, they were allowed to work on their own research topics, e.g. the topic of the next term paper, or their bachelors' or masters' thesis.

The online materials were provided via the e-learning platform 'Moodle'; most of the content was presented using descriptions in written form enriched by screenshots of relevant electronic resources. In order to make the materials more varied, some videos were included. Presenting the content via 'Moodle' entails the advantage that it is possible to track the chapters completed by each participant.

An outline of the content is displayed in Table 1. Chapter 1 contains basic information about finding scholarly information. Aside from a description of the most important publications types, the publication cycle is introduced: empirical findings are usually first published using empirical articles or conference contributions. Review articles and meta-analyses are used to aggregate findings from several studies. Well-established theories might later become part of textbooks. Another part of the first chapter is information about citation styles. The second chapter introduces the basics of information seeking in electronic resources like the distinction between keywords and thesaurus terms or the use of advanced search strategies like Boolean operators or truncation. Chapter 2 also introduces the most important information resources for scholarly psychology information: bibliographic databases and Google Scholar™ and outlines differences between the two kinds of resources. The third chapter describes the

use of Google Scholar™ including the advanced functions. The fourth chapter deals with the use of the scholarly databases PsycINFO™ and PSYNDEX™ which are the most important databases for psychology students (at least in German speaking countries). The chapter aims to inform about advanced search strategies – especially those functions that distinguish bibliographic databases from Google Scholar™ or other internet resources. An important additional aspect was to inform about advantages and disadvantages of these resources. There was particular emphasis on conveying that the selection of the information resource should be made based on the kind of information needed. The fifth chapter described ways to identify psychological tests. As the audience was German psychology students, mainly resources for identifying German language measurement instruments (like the German bibliographic database PSYNDEX™) were introduced. Chapter 6 informed about ways to actually access the full-texts of literature that had been identified in previous steps. Participants were informed that many journal articles can be obtained via electronic journal subscriptions which can be identified via the use of link resolver services. Additionally, interlibrary loan was introduced as findings related to student's use of this service are mixed (Catalano 2013). The seventh chapter informed about ways to find related literature. Mainly three strategies were introduced: Extracting keywords from the available publication and using these keywords for further research. Second, a viable strategy – especially with older publications – is to search for citing publications what can be done via Google Scholar™. The third strategy presented was to search for further publications by the same author or research team. The last chapter informed about criteria for the evaluation of scholarly publications (e.g. citation indices) and taught the participants how to read abstracts correctly to preliminary select publications. Another

part of this chapter were criteria for the evaluation of information found on websites and ways to integrate information with differing viewpoints.

As materials presented via Moodle consist of several elements (e.g. text pages, lections, quizzes, videos, PDF documents) which differ in length, it is impossible to provide objective information about the length of each chapter. However, chapter 4 (bibliographic databases) was the most extensive chapter followed by chapters 6, 7 and 8 which were approximately equally extensive. The remaining chapters were comparatively short.

----------insert table 1 here----------

As outlined above, we expected fragmented knowledge with individual strengths and weaknesses among the participants. Therefore, the choice was made to match instruction to individual differences following a remedial strategy (cf Carrier and Jonassen 1988) that is to provide instruction in a way that individual deficits can be overcome. Concerning the way instruction is offered, an adaptable teaching approach was selected: in the current study, participants were allowed to choose which chapters they were going to complete. Furthermore, as suggested by Brophy (2010) and Kanar and Bell (2013), individual recommendations concerning the chapters that should be completed were provided. To implement adaptable teaching in this fashion, a pre-test was used to identify individual deficits. The test items were assigned to the chapters of the online materials; thereby, some items were assigned to several chapters, while other items could not be assigned to one of the chapters. Each chapter was assigned at least five items. When deriving recommendations, all items related to one chapter were averaged. If a participant achieved less than 66% of the maximum score, the

recommendation was given to complete the relevant chapter. Chapters in which the participants were not deficient (more than 66% of the total score) were marked as optional. Drawing the line at 66% seemed appropriate, as there are always several equally effective ways to find information. For students, it is not necessary to know all these options; therefore, a relatively low benchmark was chosen compared to traditional mastery tests. Students were provided access to the online materials after completing the pre-test and receiving their individual recommendations. The completion of the online materials was intended to level out differences in previous knowledge among the participants, so all participants should be roughly equal in knowledge when taking part in the classroom seminar.

Of course, a large number of concepts for the instruction of information literacy in higher education have already been published. However, many instruction efforts are not evaluated at all or the only evaluation measure are subjective assessments (Schilling and Applegate 2012). Using self-reports as the only evaluation tool is problematic as there is evidence that students tend to overestimate their information literacy skills (e.g. Gross and Latham 2012). Certainly, there are studies examining the effectiveness of instruction efforts or comparing several instructional methods (e.g. Detlor et al. 2011; Mery, Newby, and Peng 2012) and even review articles concerning that issue (Koufogiannakis and Wiebe 2006). However, many studies show methodological weaknesses, for example, some evaluation studies reviewed by Koufogiannakis and Wiebe (2006) lack a control group. In other studies, data was only collected after the intervention (the experimental group and a control group are compared based on post-test data only). Furthermore, to our knowledge, this is the first study presenting and evaluating an adaptive information literacy instruction program that is tailored to the

previous knowledge of the participants. Another feature of the concept for information literacy instruction presented here is that it is designed to fit the usual workflows at universities and colleges. Taking into account that most information literacy instruction is delivered as one-shot session, this single session could simply be used to accommodate the classroom seminar while the students complete the online materials at home before coming to class.

Hypotheses

In this section, one hypothesis and one research question are expressed. According to the hypothesis, it is expected that those participants who completed a chapter should achieve a higher gain on those items of the test that are assigned to the relevant chapter than those participants who did not complete that chapter. While this hypothesis might seem trivial, its confirmation is an important prerequisite for the examination of the following research question.

The purpose of the research question is to examine the effectiveness of the adaptable teaching approach. It assumed that three groups of participants will be identifiable: those who completed fewer chapters than recommended, those who followed the recommendations closely, and those who completed more chapters than recommended. Concerning the overall learning progress, we expected that those participants who followed the recommendations or completed additional chapters show better learning progress than those students who completed fewer chapters than recommended. Of particular importance is the examination whether completing additional chapters leads to better learning progress than following the recommendations closely. If completing additional chapters does not lead to better learning, this is an indication that the recommendations point adequately to individual deficits.

Method

The sample consisted of $N = 64$ psychology students from the University of Trier, Germany. Among them, there were $n = 31$ undergraduate level and $n = 33$ master level students. The mean age was $M = 24.97$ ($SD = 3.63$); out of 64 participants, 56 (88%) were female. The course was offered five times; participation numbers ranged from 8 to 14. The participants were required to take part in two data collection sessions: one before and one after the instruction program. Data was collected in group sessions in a computer lab of the University of Trier where the participants completed the instruments described below via online survey software. The group sizes were the same as for the course participation. After the first data collection, each participant received an email containing recommendations concerning the chapters to be completed. Then, the participants had four days to complete the online materials before the classroom seminar was scheduled. The final data collection took place two days after the classroom session. The classroom seminar was held by a faculty member who was assisted by a student assistant. The library was not involved to make sure that implementation conditions were the same every time the course was offered. Every student was provided with an individual 'Moodle' account, so it was possible to track which chapters were completed by each person. Participation was completely voluntary; participants were paid for their participation in the data collections.

Instruments

Three instruments were used for the evaluation of the instruction program: a) a fixed-choice test assessing knowledge in psychology specific information literacy, b) a situational judgment test assessing whether students were able to choose the right solution when information needs are presented. Finally, c) self-assessed abilities in finding scholarly information were assessed using a self-assessment-scale.

The fixed-choice test contains 50 items and covers the field of psychology specific information literacy in a relatively broad sense. The test is based on previous work of our research group (Leichner et al. 2013). Items deal with the use of bibliographic databases, and Google Scholar™, but also with the use of the library catalog, interlibrary loan, and other related topics. Three sample items of varying difficulty can be found in the appendix along with the item mean scores from t1. Most items have three response options, out of which one, several, all or none can be correct. Two items require a free response which can be scored objectively using rubrics. Partial credit is given if only some of the response options are answered correctly (marked or left out). No more than one point is awarded for each item. To compute the total score, all item scores are averaged, so the total score can vary between zero and one. In the current study, this test was used to derive individual recommendations concerning the chapters that should be completed as described above.

The situational judgment test contains 22 items. Items begin with a description of a problem situation requiring an information search (e.g., 'You need the following book: "Richard S. Lazarus - Stress, Appraisal, and Coping". How do you proceed?'). Subsequently, four response alternatives (e.g., 'I look up the ISBN-Number of the book and enter it into the library catalog'; 'I try to locate and download a .pdf of the book using a web search engine'; etc.) that are to be rated on a 5-point Likert-Scale ('not useful at all' to 'very useful') are presented to participants. A scoring key is available determining the most appropriate order of rank of the response alternatives. Credit is given for each of the six possible pairwise comparisons of response alternatives that are in line with the scoring key (for a detailed description see Rosman, Mayer, and Krampen 2015). Satisfying psychometric properties have been reported as well as high

correlations ($r > .60$; $p < .01$) between the test and performance in standardized information search tasks which can be interpreted as indication of validity (Rosman, Mayer, and Krampen 2015). To make scores comparable to scores on the fixed-choice test, scores on this instrument are scaled in a way that the total score can range from zero to one.

For the self-assessment of abilities in finding scholarly information, a short scale containing ten items was created. Each item has to be answered using a 5 point Likert scale with a sixth option labelled 'don't know' (Sample item: 'I know how to use bibliographic databases to find relevant literature'). During the analyses, 'don't know'-responses are considered missing data. The ten items are averaged when computing the total score, so the mean score can range from one to five. In previous studies, satisfactory internal consistencies were found (Leichner 2015).

Results

Mean scores and standard deviations for the three instruments at the two data collections (t1 and t2) are displayed in table 2. The internal consistencies of the scales reached satisfactory levels. The fixed-choice test showed an internal consistency of $\alpha = .80$ at t1, and $\alpha = .76$ at t2. The situational judgment test displayed an internal consistency of $\alpha = .66$ at t1 and $\alpha = .63$ at t2. For the self-assessment, internal consistencies of $\alpha = .66$ (t1) and $\alpha = .69$ (t2) were found. For all calculations relating to the self-assessment scale, missing data (e.g. the participants marked the 'don't know'-option) was handled using pairwise deletion.

------insert table 2 here----------

Before examining the hypotheses, it was confirmed that participants scored higher on all instruments after participating in the instruction program. As can be seen

in table 2, this was the case. In the next step, it was determined whether the differences displayed in the table are significant in a statistical sense. Using dependent *t*-tests, we found significant ($p < .01$) differences on all instruments used. Participants scored significantly higher after participation on the fixed-choice test ($t[63] = -18.53$), and on the situational judgment test ($t[63] = -9.98$). A similar pattern could also be found when examining scores on the self-assessment scale ($t[63] = -9.89$).

When investigating the number of recommendations concerning each chapter, it was found that only seven students (11%) were recommended to complete chapter 1, while chapter 2 had a recommendation rate of 47% (30 students). On average, the remaining six chapters were recommended to 46 students (72%).

It was also determined to what extent the participants followed the recommendations given. As expected, three groups of participants could be identified. Out of 64 participants, 11 participants completed fewer than the recommended chapters (group 1), 21 followed the recommendations closely (group 2), and 27 completed the recommended chapters, but also completed additional chapters (group 3). Finally, five participants did not follow the recommendations by completing several non-recommended, as well as not completing several recommended chapters. These participants could not be categorized in one of the three groups above. On average, group 1 had been recommended to complete around six chapters, while the other groups had been recommended to complete between four and five chapters.

Our hypothesis states that those participants who completed a chapter should achieve a higher gain on those items of the fixed-choice test that are assigned to that chapter than those participants who did not complete that chapter. Separate computations were made for each chapter which are reported in table 3. The table contains the number of participants who had completed a chapter and those who had

not, as well as pre and post results for the performance on those items of the fixed-choice test that were assigned to that chapter. The results show that for most chapters, only those participants who had completed them (no matter whether at their own initiative or following our recommendations) displayed an increase on the items assigned to that chapter. There are three exceptions (chapters 4, 6 and 8); however, in these three cases, the effect sizes are much larger for those participants who actually completed the chapters, as can be seen from the *t*-values.

----------insert table3 here……..

For the examination of the research question, the sample was split up into the three subgroups defined above. Group 1 (n = 11) contained those participants who completed fewer than the recommended chapters. Group 2 (n = 21) followed the recommendations closely, while group 3 (n = 27) completed all recommended chapters, but also completed additional ones. Those five participants, who completely ignored the recommendations, were excluded from this analysis for the sake of stringency. When investigating change in scores on a certain instrument, computing the difference between pre-test score and post-test score is problematic as it does not account for differences in pre-test scores (Cronbach and Furby 1970). Therefore, to determine the increase in scores on the three instruments, residuals were computed according to Wilder's law of initial value (Wilder 1962) by using the t2-value as dependent and the t1-value as independent variables. Residuals should not be interpreted as absolute values, as they identify deviation from the average increase. So, a negative value indicates that the group had a smaller gain than average. Residuals for the three groups are displayed in table 4.

----------insert table 4 here----------

As can be seen in table 4, residuals for groups 2 and 3 deviate only slightly from average, while residuals for group 1 deviate downwards from the average score. For further examination, a multivariate analysis of variance (MANOVA) was computed to examine group differences on the residuals of the three instruments simultaneously. Wilk's Lambda pointed to significant overall differences ($\Lambda = .74$, $F(6,108) = 2.93$, $p < .05$). Separate analyses of variance were computed next. For the fixed-choice test, a significant overall difference was found ($F[2,56] = 3.89$, $p < .05$). To investigate this difference further, linear contrasts were calculated indicating a significant difference between groups 1 and 2 ($d = -.03$, $p < .05$), but no significant difference between groups 2 and 3 ($d = -.01$, *ns*).

A significant overall difference was also found for the situational judgement test ($F[2,56] = 5.13$, $p < .01$). Linear contrasts revealed a significant difference between groups 1 and 2 ($d = -.73$, $p < .05$), but no significant difference between groups 2 and 3 ($d = -.27$, *ns*). The same pattern was also found for the self-assessment scale: The overall difference reached significance level ($F[2,56] = 2.40$; $p < .10$); linear contrasts revealed a significant difference between groups 1 and 2 ($d = -.77$, $p < .05$), but no significant difference between groups 2 and 3 ($d = -.09$, *ns*).

Discussion

The aim of this paper was to present an adaptable Blended Learning approach to information literacy instruction in which participants can choose which parts of the online materials they are going to complete. Participants are given recommendations to guide this decision. In summary, it can be said that the concept for information literacy instruction presented in this paper can handle the two main challenges which information literacy instruction at colleges and universities has to face. First,

information literacy instruction can be scheduled flexibly and has to be delivered in a time-efficient manner. Second, teaching concepts should be designed in a way that they can accommodate individual strengths and weaknesses. The concept handles these requirements in two ways: (1) Most of the content is imparted by the online materials which can be completed by the students at their own pace and according to their own schedule. (2) By using adaptable teaching, individual deficits can be targeted.

It was found that the vast majority of students accepted the recommendations. There were only five students who obviously ignored the recommendations. It should be mentioned that those 11 participants who completed fewer chapters than recommended (group 1) also had to complete more chapters than the other groups. Possibly, these students simply did not find the time to complete all chapters within four days. It is striking that so many students completed more chapters than recommended (group 3); however, the most important finding is that around 75% of the participants (groups 2 and 3 combined) completed at least the suggested chapters. This is a very important finding as an evaluation of the instruction program would not be possible with large numbers of students not following the recommendations. A possible explanation is that the pre-test draws the students' attention to their deficits what increases their motivation as suggested by Price et al. (2011).

The findings related to the hypothesis indicate that it is possible to tackle deficits related to a certain chapter; however, the most important conclusion that can be drawn from the findings is that the way items and chapters were matched is appropriate.

The findings related to the research question are the most essential aspect of this study. The results show that completing more chapters than recommended does not improve learning compared to following the recommendations strictly. This

demonstrates that the procedure used for deriving recommendations was able to identify individual deficits correctly and that the adaptable teaching approach used is effective.

It is worth noting that the concept does also fit the usual workflows at colleges or universities quite well. As described above, the majority of information literacy instruction efforts are one-shot-sessions held by a librarian and integrated into a subject-related course (Fister and Eland 2008). This is often criticized as it does not allow comprehensive information literacy instruction (Grassian and Kaplowitz 2009). The findings demonstrate that it is possible to offer relatively comprehensive information literacy instruction in the course of a single classroom seminar if the seminar is supplemented by online materials. So, the concept presented here can improve information literacy instruction without requiring an additional information literacy course.

Of course, completing the online materials will take additional time for students; however, completion will take between three and seven hours which seems a reasonable workload for college students. We strongly recommend that the classroom seminar is held by a librarian and a faculty member in cooperation, as their areas of expertise are complementary and there are several reports about successful collaboration projects between psychology faculty and librarians (e.g. Birkett and Hughes 2013; Paglia and Donahue 2003). Concerning the content of information literacy instruction, the findings of the pre-test indicate that most students are deficient when it comes to finding, accessing and evaluating literature, while basic information (especially the content of chapter 1 in the present study) seems to be sufficiently covered by existing courses.

Nonetheless, several limitations of this study should be mentioned. First of all, this study lacks relevant control groups that either did not receive any information literacy instruction, or did not receive adaptable instruction. So, it is not possible to rule

out that the improvement in information literacy skills did happen by incidence. However, as the duration of the instruction program presented here was one week, it seems implausible that students' information literacy skills would have improved to the same extent without intervention. Furthermore, a similar information literacy instruction program without adaptable teaching was successfully evaluated by our research group using a control group (Leichner et al. 2014). Nonetheless, it is not possible to determine whether improvement would have been different without adaptable teaching. However, the findings related to both our hypotheses indicate that the procedure for deriving recommendations was able to identify individual deficits quite well.

Second, some items of the pre-test were assigned to several chapters of the online materials. This reflects the interrelatedness of the chapters – a feature certainly common to many textbooks. From a psychometric perspective, however, this is problematic as chapter recommendations are not statistically independent. For the purpose of guiding students through the online materials, this shortcoming is not important. If the recommendations were to be used for analyses leading to high stakes-implications, this would be problematic.

Another issue to be discussed is whether the findings can be generalized as they are based on a relatively small sample of psychology students. The findings related to the hypothesis are assumed to be generalizable as there are several studies showing that information literacy instruction can be effective. There is no reason to assume that this does not apply to single chapters that are part of an instruction program. The finding that completing more chapters than recommended will not entail higher gains in information literacy is certainly dependent on the nature of the test used and the matching of test items and content of the online materials. We do believe, however, that it is possible to replicate this finding. Finally, the finding that the majority of

participants completed at least the recommended chapters may be attributed to the fact that participation was completely voluntary, so participants were certainly more motivated than average students. Further research should investigate this, too.

The two final points to be addressed refer to the analyses reported here. When examining the hypothesis, we compared participants who had completed a chapter with those who had not completed the relevant chapter. As the number of completers differs between chapters, each analysis is based on different group sizes what might reduce their comparability. When examining the research question, five participants who did not comply with the instructions were excluded from the analysis. Future research might identify variables that are associated with ignoring the recommendations. Another issue for future research is to examine the sustainability of the learning progress by conducting a follow-up measurement, for instance at the time of graduation.

To sum up, the results presented here indicate that supplementing the existing one-shot-sessions for information literacy instruction by online materials is a viable way to improve information literacy instruction without many changes to the workflows at universities and colleges. To our knowledge, this is the first study presenting and evaluating an adaptable approach to information literacy instruction. Based on the findings of the pre-test presented here, it can be recommended to focus instruction on skills related to finding, accessing and evaluating information.

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Table 1

Content of the online materials

Chapter	Title and content
1	Scientific system (most important types of scholarly literature, e.g. monographs, contributions to edited books, journal articles, basics of the APA citation style)
2	Basics of searching (comparison of Google Scholar™ and bibliographic databases, distinction between keywords and controlled vocabulary, efficient search strategies, e.g. Boolean operators, and truncation)
3	Searching with Google Scholar™ (functioning of the Google Scholar™, advanced search functions, disadvantages of Google Scholar™ compared to bibliographic databases)
4	Searching in scientific databases (Description of PsycINFO™ and PSYNDEX™)
5	Searching for psychological tests (Search in bibliographic databases, and sales catalogues)
6	Accessing scientific literature (use of link resolvers, the library catalogue, and interlibrary loan)
7	Finding related literature (extracting keywords from available literature, searching for citing publications, other publications from same author)
8	Evaluating information (understanding abstracts of publications, interpreting measures like Journal Impact Factor, or h-index)

Table 2

Mean scores and standard deviations for the instruments at the two data collections

Instrument	t1 *M*(*SD*)	t2 *M*(*SD*)
fixed-choice test	0.61 (0.07)	0.75 (0.07)
situational judgment test	0.69 (0.10)	0.77 (0.09)
self-assessment	3.02 (0.65)	3.75 (0.47)

Table 3

Mean scores, and increase on relevant items for each chapter

Chapter	not completed				completed			
	n	t1 M(*SD*)	t2 M(*SD*)	*t*-Values	*n*	t1 M(*SD*)	t2 M(*SD*)	*t*-Values
1	38	.80 (.08)	.81 (.09)	-.74	26	.75 (.15)	.82 (.07)	-2.58 *
2	20	.74 (.09)	.79 (.13)	-1.75	44	.64 (.12)	.81 (.10)	-11.38 ***
3	16	.65 (.12)	.71 (.09)	-1.79	48	.46 (.14)	.69 (.10)	-11.63 ***
4	21	.66 (.11)	.75 (.11)	-4.19 ***	43	.53 (.12)	.78 (.09)	-10.93 ***
5	11	.60 (.20)	.65 (.17)	-1.56	53	.48 (.12)	.67 (.15)	-9.44 ***
6	16	.60 (.14)	.65 (.13)	-2.51 *	48	.53 (.13)	.80 (.10)	-14.08 ***
7	24	.68 (.13)	.71 (.19)	-.77	40	.54 (.11)	.72 (.14)	-8.62 ***
8	22	.66 (.14)	.75 (.11)	-4.95 ***	42	.61 (.10)	.81 (.07)	-12.10 ***

Note. * $p < .05$. *** $p < .001$

Table 4

Residuals following the law of initial value for the three groups

	group		
	group 1 *M*(*SD*)	group 2 *M*(*SD*)	group 3 *M*(*SD*)
fixed-choice test	-.04(.05)	.00(.04)	.01(.05)
situational judgment test	-.80(.76)	-.07(.90)	.20(.90)
self-assessment	-.62(1.49)	.15(.89)	.05(.80)

Appendix sample items from the fixed-choice test

Why does the query "Personality AND false memories" provide fewer results than the query "Personality OR false memory"? (*M* = .94; *SD* = .14)

- **Combining two search terms using "AND" restricts the results to entries associated with both terms. When combining the terms using OR, all entries are found that are linked to one of the terms, or linked to both.**
- More entries are associated with the word "OR" than with the word "AND".
- "OR" leads to the inclusion of additional resources which would otherwise not be used.

What is the most common use of the function to display citing articles ("cited by") in Google Scholar™? (*M* = .56; *SD* = .36)

- **To identify publications dealing with the same (or a similar) topic.**
- **To estimate how influential the relevant article is in its topic area.**
- To find out whether parts of the wording of the relevant publication have been adopted by other authors.

Which statements about the order of author names are correct? (*M* = .37; *SD* = .22)

- **In some cases, the order is defined by chance.**
- **Often, the order of the author names reflects the contributions of the authors.**
- **Established authors are often mentioned at the end of the list.**

Note: correct response options are highlighted in bold. Mean scores and standard deviations for each item from t1 are displayed to provide an estimate of item difficulty. Higher mean scores indicate easier items.