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Title of the project: **Improving skills in dosage calculation**

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Background

Administering medication is one of the high-risk tasks a health care professional should be able to perform. The overall purpose of the development project MAQ (Medication administration qualification) is to prevent medication errors and to improve patient safety.

Sigma is a tool in the MAQ project, a web application and a learning environment for practising dosage calculation and for dosage calculation tests. Sigma offers both students and professionals a safe and supportive learning environment for training drug dosage calculation.

When doing exercises in Sigma, the user is offered five randomized calculation problems, displayed one at a time. The problems usually contain one question but can also be structured into two or three sub-questions. The user provides the answer by entering a value into an input field and choosing the correct unit from a dropdown list. The user is also expected to enter a description of the problem solving procedure into a commenting box. After submitting the answer, Sigma provides immediate feedback, but instead of revealing the correct answer Sigma provides a model solution, aimed to support the user to develop an understanding of how the current type of problems should be solved.

Aim of project and research questions

The aim of this part of the project has been to develop the learning environment Sigma from a user perspective regarding technical usability, pedagogical usefulness and learning dosage calculation.

The research questions covered both the technical usability and the pedagogical usefulness of the learning environment:

1. How did the technical and graphical solutions of the user interface meet the needs of the user?
2. To which extent did the students find practising drug calculation in Sigma useful?
3. How did working in the Sigma learning environment improve learning in dosage calculation?

Research method
In this study the learning environment Sigma was pilot tested by 171 pharmacy students in autumn 2009. Students were given two compulsory assignments; to practise drug calculation by using the Sigma learning environment and to provide feedback about it.

During the testing period 164 students used Sigma, and their actions in Sigma were recorded in a log. Moreover, data regarding students' experiences of Sigma were collected using a web questionnaire with both attitude items on a visual analogue scale (VAS), and open-ended questions. The response rate was 96.5 % (n=165), partly due to the compulsory assignment. Thus, the approach in the analysis was both qualitative and quantitative.

In order to compare the reported experiences with performance, some log data, describing the number of solved problems and the number of correct and false answers respectively, was extracted from the Sigma environment. The log data table and the survey data table were then joined. The log data revealed that the extent to which students used the Sigma environment varied widely, between 1 and 90 solved problems with an average of 19.5.

The number of correct answers ranged from none to 78 and the incorrect answers from none to 18. A correct answers quota was generated by dividing the number of correct answers with the number of solved problems. This quota showed that there where students who failed in all the problems they tried to solve, but also students who solved all their problems correctly, the mean value being 0.76. Furthermore, the students were asked to estimate their drug calculation skills on a school grade scale from 5-10. The estimations ranged over the whole scale from 5 to 10 with an average of 8.21.

The difficulty level item (very easy .. very difficult) scored values between 1 and 80 with an average of 29.7 suggesting that the students experienced the problems rather easy or moderate, and no one experienced them as very difficult. There was a strong correlation between estimated calculation skills and experienced difficulty level (corr. -.567 at Sig. .000). This is also expressed in the mean value of experienced difficulty being significantly higher (M=45.44) among the low-graders (grade 5-7) compared to the high-graders (M=25.16).

The usefulness item (very poor .. very good) scored values between 1 and 100 with an average of 45.5 suggesting that the students deemed Sigma as moderately suitable for this purpose.

The big differences in student activity arouse the suspicion that those who had used Sigma only a few times may not have been able to express informed opinions about Sigma. Hence, the students were split into two groups: the active ones who had solved ten problems or more (n=131) corresponding to

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two whole sessions, and the inactive ones who had solved only nine problems or less (n=33).

The open-ended questions yielded a large amount of thorough answers, which reflects a high level of engagement. The material containing 50 printed pages was analysed by content analysis. Forcing respondents to participate in a survey is known to affect the trustworthiness of the answers. In this case, the thorough answers to the open-ended question suggest that the respondents did not answer the survey without commitment.

Results

Most of the students were content with the learning environment and found it easy to use. Students also appreciated the availability of the tool, being able to use it at any computer and without time restrictions. The following features in the Sigma user interface were criticized and will be subject for future development:

- A more inspiring graphical interface.
- The dropdown list for choosing unit was bothersome to use.
- Describing the problem solving procedure in the input field was difficult.
- Lack of a calculator.

A majority of the students experienced that Sigma was a useful tool in practising drug calculation. However, some students wanted more challenging problems and problems more related to their specific area of interest - pharmacy. The problems containing 2-3 sub-questions were experienced as the most challenging. Furthermore, intravenous medication made the students curious to investigate an area that might be important for only a few of them in their future working life.

The usefulness expressed in the open-ended questions was supported by the quantitative data. Within the active group, there was a correlation between experienced usefulness and number of solved problems (.301 at Sig .003), suggesting that those who liked the environment also used it more frequently.

A majority of the students expressed in their comments that Sigma as a learning environment supported them in improving their skills in drug calculation. However, some students criticized that the user is not allowed to review an earlier question.

The answers from the active students revealed a correlation between experienced difficulty and the correct answers quota (corr. -.379 at Sig .000). This suggests that those who found the problems easy also succeeded better when practising in Sigma.

It may be a bit surprising that students who estimate their drug calculation skills as rather poor still choose to study pharmacy. A possible explanation may be that students simply underestimate their skills. Among the active group those who estimated their skills as good also succeeded better which was expressed by the correlation between the estimated skills and the correct answers quota (corr. .388 at Sig. .000). The correlations mentioned above could not be observed within the inactive group, which supports the assumption that their answers may be unreliable.

Conclusions

This pilot study offered important information suggesting that the user friendliness of the learning environment is satisfactory, but can still be improved.

The target group - pharmacy students - experienced that the calculation problems in Sigma were useful and beneficial although they found that the problems were more directed to nursing professionals. To confirm this, the study should be revised and replicated among nursing students. This finding also suggests that features should be developed in Sigma to define a personal user profile and to match the problems to the user profile.

Some informants appreciated the pedagogical approach where model solutions with several ways to solve the specific calculation were presented. Other students wanted the correct answer instead of getting suggestions how this type of calculation problem is solved. Future studies should be designed to distinguish the preferences of the different students.

The results suggest that students with weaker calculating skills did not practise as much ($\underline{M}$=13.36 problems) as those with better skills ($\underline{M}$=21.17 problems). On the other hand, those with weak skills should practise more to improve their skills. However, this material does not reveal why those with weak skills didn’t practise. Future studies should focus on the question if the Sigma environment contains features repulsing the weak students.

In their comments the students expressed that Sigma supported their learning. In order to confirm this, longitudinal logs should be collected to explore if practising in Sigma actually contributes to improving drug calculation skills.

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