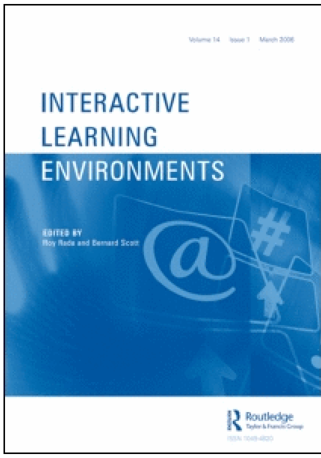

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The impact of computer supported collaborative learning on internship outcomes of pharmacy students

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The impact of computer supported collaborative learning on internship outcomes of pharmacy students

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This article focuses on an evaluation of the impact of an innovative instructional design of internships in view of a new integrated pharmaceutical curriculum. A key innovative element was the implementation of a computer-supported collaborative learning environment. Students were, as part of their formal curriculum, expected to work in a systematic and collaborative way in discussing and solving real-life cases. Students in the role condition were assigned specific roles. The cases were an additional critical variable in the study. The results of the study demonstrate that both independent variables (role assignment and cases) have a significant impact on levels of knowledge construction and, especially, on the attainment of objectives of the new integrated pharmaceutical curriculum.

Keywords: asynchronous discussion groups; computer-supported collaborative learning; knowledge acquisition; higher education; roles

Introduction

> Pharmacy practice demands that pharmacists draw upon competencies and outcomes that enable them to perform the functions that support the delivery of pharmaceutical care. (Alsharif, Destache, & Roche, 1999, p. 34)

The former observation has heavily influenced the design and development of curricula and accreditation standards. At the same time, a large variety of innovations in the instructional design of pharmaceutical education have been researched and implemented. The present study was set up to research an innovative approach to guarantee the evidence-based use of integrated pharmaceutical knowledge of internship students.

Integrated pharmaceutical knowledge and curriculum reform

Curriculum design in developing optimal competencies in pharmaceutical care implies that students integrate the conditional knowledge and skills with a view to coping with clinical situations in a rational and logical way. This implies that they have to apply their prior knowledge base in analysing and interpreting patient case data. In the context of the curriculum of Ghent University in Belgium an important curriculum reform was introduced in 2002 to stress the importance of this central objective.

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In line with international trends (Beardsley, 2001), an evidence-based approach and a competency-based orientation of the curriculum were adopted. The new integrated curriculum consists of four sets of competencies to be attained by students at the end of their study: (1) general societal competencies that stress the importance of communication skills, critical skills, ethical issues, health policy, and management issues, deontological issues, legal issues, and, finally, competencies related to innovations in the profession; (2) research-related competencies that reflect applied scientific research skills and the execution of laboratory procedures; (3) pharmaceutical discipline-related knowledge that comprises (a) chemical, therapeutic, pharmacological, toxicological, and biomedical knowledge, (b) objectives focusing on patient care and sound use of drugs, and (c) the production of drugs and quality control.

The implementation of the new curriculum has especially affected the instructional design of the internship of 26 weeks in the fifth year of the pharmacy educational programme. The present article focuses on the impact of this redesign on educational outcomes.

Redesign of the internship learning environment: cases and collaborative learning

The instructional redesign has directed the way internships are now being set up in two ways. Instead of an independent internship, students are now also formally expected to be involved in a structured computer-supported collaborative learning environment (CSCLE) during their internship. In the CSCLE they have to discuss and solve five real-life cases.

The case-based approach offers rich opportunities to present interns with real-life problems. The cases have been developed in a systematic way to guarantee that they cover the full complexity of the new curriculum: an impetigo case; a case related to Clamoxyl® prescription in relation to tooth extraction; a rheumatism case; a case of fsevere persisting headache; a case of hypertension. Next to a description of the patient, questions concerning the patient, and information on any prescriptions by a GP, the students were presented with some guiding questions that queried the nature of the prescription, the relevance of the medication, symptoms, argumentation for alternatives, etc. Each case was dealt with over two weeks. To guarantee the real-life nature of the cases a researcher intervened in a standardized way after 1 week and introduced new information about the case. In the impetigo case the patient left the country to travel to India and fell ill. Internship students were expected to consider the additional complications of this development in the case.

Each case was analysed by a team of specialists to indicate the objectives that could be pursued by the specific case. This guaranteed the validity of the cases concerning the pharmaceutical curriculum and guided the assessment and evaluation of student input when discussing and solving the case.

The CSCLE ensured that students had to collaborate online with other internship students to discuss and solve the pharmaceutical cases. It is hypothesized that online collaboration fosters knowledge acquisition and competency development due to the explication of knowledge and skills and the exchange and sharing of information (De Wever, Van Winckel, & Valcke, in press).

Working in a CSCLE can be considered a particular form of cooperative learning that, considering the extensive empirical base available, has proven to be beneficial on a large number of outcome parameters (Johnson, Johnson, & Holubec, 1994; Slavin, 1995). The approach can be compared to problem-based learning approaches, with the key ingredients social and personal learning processes and learners' shared experiences, responsibility, monitoring, and self-regulated learning (Stromso, Grottum, & Hofgaard Lycke, 2004). This is in line with social constructivist assumptions about knowledge acquisition (Duffy & Jonassen, 1992; Salomon & Perkins, 1998; Schellens & Valcke, 2006; Stahl, 2004, 2005). Empirical evidence is available in the literature to support these assumptions (for an overview see Schellens, Van Keer, Valcke, & De Wever, 2007). De Wever et al. (in press) summarizes four advantages of applying the computer-supported collaborative learning approach: (1) students have opportunities to practice using information and communication technologies in the context of their professional training (Hagdrup et al., 1999); (2) students are forced to keep up with the rapid growth in / pharmaceutical knowledge; (3) the asynchronous nature of online discussion groups makes the learning environment independent of time and location and suitable to cope with the distributed characteristic of internships (Bernard & Lundgren-Cayrol, 2001); (3) asynchronous discussions provide students with time to reflect, think, and search for additional information before contributing to the discussion (Pena-Shaff & Nicholls, 2004); (4) asynchronous discussion groups can be used to integrate clinical placements within the instructional design (Hagdrup et al., 1999).

Despite the available empirical evidence on the impact of CSCLE, some authors also point at non-conclusive results of a number of studies (Archer, Garrison, Anderson, & Rourke, 2001). Empirical studies on the impact of CSCLE have led to the definition of some guiding design principles that are especially related to structuring the contributions of students. Specifically the assignment of roles is considered of importance to activate, stimulate, and orientate the students (Strijbos, Martens, Jochems, & Broers, 2004). In the present study four roles were presented to students: (1) the moderator, who launches the discussion and fosters the continuous active participation of other students in the group; (2) the question asker, who continuously posts critical questions and/or links questions to clarify the contributions of other students; (3) the summarizer, who is expected to submit summaries that integrate the results of the discussions and the conclusions reached thus far; (4) a source researcher, who backs up findings, statements, and conclusions with references from the literature, research evidence, and other publications.

The assignment of roles is in line with recent research in the field of CSCLE to foster the efficacy and efficiency of collaborative learning activities. Roles fit into the recent trend to add structure to CSCLE activities. In this context the concept of "script" is put forward. A script can be defined as a detailed and explicit didactic contract between the teacher and the group of students regarding their mode of collaboration (Weinberger, Ertl, Fischer, & Mandl, 2005).

When guided by scripts the learners are stimulated to construct specific arguments by providing them with prompts to which they have to respond (Hamalainen, in press; Kollar, Fischer, & Hess, 2003; Weinberger, 2003; Weinberger et al., 2005). This approach is particularly interesting to specify, sequence, and eventually allocate different learning activities to learners. A stated above, assigning roles to students fits into the scripting approach.

Research design

Participants

A quasi-experimental design was set up to study the impact of the CSCLE. The entire population of fifth year students in the pharmaceutical programme was involved in the study ($n = 77$). The population consisted of 60 female and 17 male subjects. Students were assigned at random to a group of 7 – 8 students. Participation in the study was obligatory since the internship is a formal part of the study programme.

Procedure

Each of the 10 groups studied and attempted to solve during each case over a two week period. After two weeks a new case was presented. The first case was considered a warm-up case so that the students could become acquainted with the technology and the learning format. Data from this case are excluded from the analysis. To study the differential impact of role assignment, five groups were presented with roles and five groups did not receive role assignments. Specific roles were assigned by the researchers to randomly chosen students within the role condition. Students were expected to post at least four messages a week. The research was approved by the ethics review committee of the faculty of pharmaceutical sciences. Informed consent was obtained from all participating students.

Research variables

Two independent variables are distinguished in this study. The first variable builds on the roles. The impact of the different roles will be studied, alongside a comparison of discussions with and without roles. A second independent variable is related to the nature of the four cases. Since the cases differ in the extent to which they help to pursue subsets of specific curriculum objectives, this characteristic is considered important in the study of the impact of the CSCLE. Some authors point at the critical nature of the discussion themes or cases. Task complexity has been shown to influence a number of dependent variables in a significant way (Schellens et al., 2007).

Two dependent variables are considered in this study. The first variable measures the extent to which student contributions to the discussions mirror mastery of the learning objectives in relation to each case. Based on prior analysis by a group of specialists, student contributions at the theme level were evaluated by two independent researchers. This resulted in an Integrated Curriculum Score (ICS) for each student and discussion. In the light of further analyses these ICS scores were standardized. In the CSCLE literature hardly any research is available that has studied the impact on actual knowledge and skill acquisition. Most studies focus on indirect outcome measures (knowledge construction, types of contributions, number of contributions, etc.).

A second dependent variable focused on the level of knowledge processing. The analysis model of Veerman and Veldhuis-Diermanse (2001) was adopted, which distinguishes between four levels of task-oriented communication. It is hypothesized that students in the CSCLE will attain higher levels of knowledge construction. Three consecutive levels of knowledge construction are distinguished, representing higher levels of knowledge construction.

(1) Presentation of new information. Learners present information that is new in the context of the discussion. Further distinction is made between the presentation of information on:
   (a) facts, for example "On the internet you can find some examples of exercises and you get the solution if you click on the following link ...";
   (b) experiences or opinions, for example "I personally would choose to explain to the other students why we accepted these students with emotional disabilities ...";
   (c) theoretical ideas, for example "I found a definition of constructivism, constructivism means active learning .... ."
(2) Explication. This is a type of communication that reflects a further refining and/or elaboration of earlier ideas, for example "I know that A already mentioned that

adding some links to the learning environment would make it a more constructivist one. I would like to go further into this by giving a few examples of the kind of links that I think could be useful . . . ."

(3) Evaluation. This type of written message corresponds to a critical discussion of earlier information or ideas. It goes beyond a simple confirmation or negation and reflects arguments, reasoning, justifications, for example

> I cannot fully agree on this one. I know B argued that because of these specific features one can assume that this is a constructivist learning environment. But I would like to refer to what we discussed in the working sessions, we then agreed that there had to more than 2 or 3 features . . . .

Analysis procedure

The transcripts of the discussion inputs of all 77 students in the four discussions were taken as the basis for analysis. Since the first case was considered as a try-out, the data for this case were excluded from the analysis. Each complete message by a student was considered a unit of analysis for coding. In the present study this resulted in a data set of 1559 analysis units. Only 6% of these messages were non-task-related (technical, social, planning, or nonsensical). The resulting 1466 analysis units were coded on the base of the analysis model of Veerman and Veldhuis-Diermanse (2001) at the level of each discussion for each individual student. In calculating the impact on ICS two groups in the role condition and two groups in the non-role condition were randomly selected. A total of 639 messages were analysed in calculating the ICS.

The reliability of the coding and scoring approach was controlled for by calculating percentage agreement between the two independent researchers. Inter-rater agreement was on average 94.92%, indicating a high reliability of the research data obtained.

Hypotheses

Building on the theoretical base, three hypotheses were put forward.

Hypothesis 1. The nature of the discussion case has a differential impact on the dependent variables: ICS and levels of knowledge construction.

Hypothesis 2. Role assignment has a beneficial impact on the dependent variables. Groups that are asked to follow role assignments will attain significantly higher ICS and/or an average higher level of knowledge construction.

Hypothesis 3. The nature of the role assigned to students will result in significant differences in ICS and/or the average level of knowledge construction.

Hypotheses were tested by applying analysis of variance (ANOVA). When the Levene statistic to test the homogeneity of variance is significant, Tamhane F values will be reported instead of Sheffe F statistics. $p < .01$ is put forward as the critical significance level.

Results

General results

Table 1 gives an overview of the average level of knowledge construction (LKC) obtained in the context of this case and the average ICS score obtained in relation to the cases. The number of messages in each cell are reported in parentheses.

Table 2 mirrors the impact role assignment and types of role have on the dependent variables: number of messages, the average level of knowledge construction (LKS) obtained by the population and the average ICS obtained in relation to the four cases. The number of messages in each cell are reported in parentheses.

The descriptive results in both tables suggest a differential impact of the independent variables on both dependent measures. This is tested below.

Results in relation to the hypotheses

Hypothesis 1. The nature of the discussion case has a differential impact on the dependent variables: ICS and levels of knowledge construction.

Results of a one-way ANOVA reveal significant differences in the average level of knowledge construction due differences in the cases $[(F_{3,1462}) = 3.052,\ p = .028,\ h_p^2 = .006]$. Partial η^2 points to a very small effect size. Post hoc analysis reveals that in fact only the rheumatism case differs marginally significantly ($p = .055$) from the impetigo case.

Secondly, the analysis results reflect a significant impact of the different cases on the ICS $[(F_{3,635}) = 41.89, p < .01, h_p^2 = .17]$. Partial η^2 points to a rather small effect size. Post hoc analysis indicates that all cases differ significantly from one another as to their impact on the ICS. Figure 1 gives a graphical representation of the differences in ICS. It is very obvious that the impetigo case has led to the highest level of attainment of integrated curriculum objectives.

The results of the analyses are in line with the findings of other authors that point to the critical nature of the discussion themes, problems, or cases in CSCLE (Lockhorst, Admiraal, Pilot, & Veen, 2002; Strijbos et al., 2004). The results can be explained by a

Table 1. Descriptives reflecting the relationship between the four cases and the dependent variables.

	All cases	Impetigo	Tooth extraction	Rheumatism	Severe headache
Average LKC	3.46 (1466)	3.58 (378)	3.52 (337)	3.34 (414)	3.40 (337)
Average ICS[a]	20.71 (639)	23.96 (97)	21.33 (163)	20.47 (186)	18.78 (193)

[a]Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases.

Table 2. Descriptives reflecting the relationship between role assignment and the dependent variables.

			Different roles[a]			
	No role	Role	Moderator	Source researcher	Question asker	Summarizer
Average LKC	3.47 (871)[b]	3.44 (595)	3.36 (94)	3.30 (79)	3.64 (83)	3.90 (71)
Average ICS[c]	20.17 (406)	21.49 (287)	21.74 (48)	21.51 (32)	18.02 (39)	23.85 (42)

[a]The total of messages does not equal the Role total since not all students in the role condition were assigned a role.
[b]The *n* value refers to the total number of messages of all students in the role condition, including those students not being assigned a role.
[c]Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases.

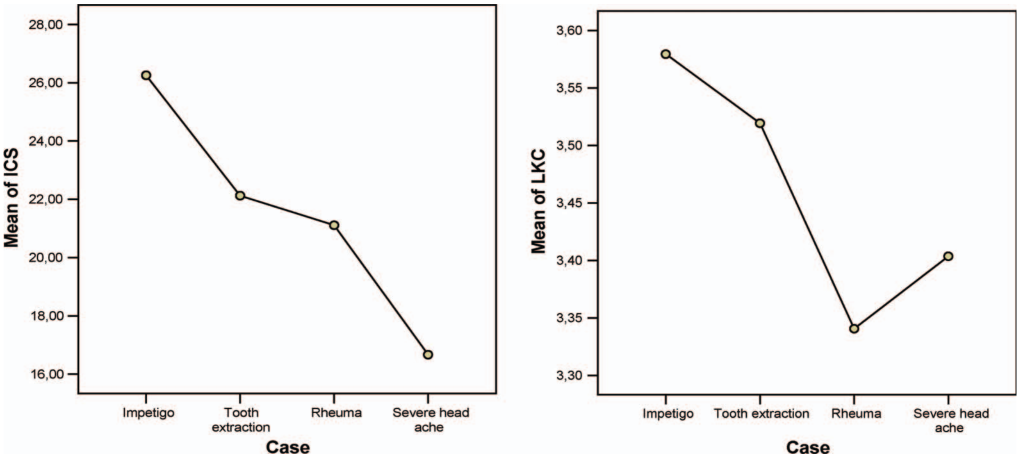

Figure 1. Graphical representation of the impact of different cases on ICS and LKC.

lower level of prior knowledge about, for example, rheumatism or severe headache. Alternative explanations can be related to task complexity. Possible indicators for this complexity can be derived from the graph about LKC in Figure 1. Parallel with a lower level of ICS we observe lower levels of knowledge construction. A third explanation refers to the internship context. The last cases were dealt with at the end of the internship when there was a higher task demand on interns to finalize their internship reports, logbook, etc. Students might have been put off by the workload. We return to this in the Discussion section.

Hypothesis 2. Role assignment has a beneficial impact on the dependent variables. Groups that are asked to follow role assignments will attain significantly higher ICS and/or an average higher level of knowledge construction.

Independent sample *t*-tests indicate that there are no significant differences in knowledge construction observed when comparing groups with or without role assignment ($t = 0.234$, $p = .815$). These results are not in line with our expectation, but do reflect comparable negative less conclusive results in the literature (Schellens, Van Keer, & Valcke, 2005). A possible explanation for the unexpected results might be an interaction effect of paying a lot of attention to the structure of the cases. Students in the no-role condition received numerous guidelines that guided them in discussing and solving the cases. The great attention paid to the task structure might have made the need for clear role assignments less crucial.

The results of the *t*-tests focusing on differences in ICS point to a significant difference ($t = -2.92$, $p < .01$). Figure 2 represents the differences in a clear way.

As stated earlier, there is hardly any research available that has thus far focused on the impact on actual knowledge and skill acquisition. These results are therefore promising and indicate that role assignment has a positive impact on competency development. The question could arise whether the impact of role assignment remains significant when considering the interaction with the case as independent variable. Additional multivariate ANOVA (Wilk's λ) still points to a significance of roles $\times$ cases on ICS [$(F_4) = 3.053$, $p < .01$, $h_p^2 = .014$]. However, it should be stressed that the effect size is very small.

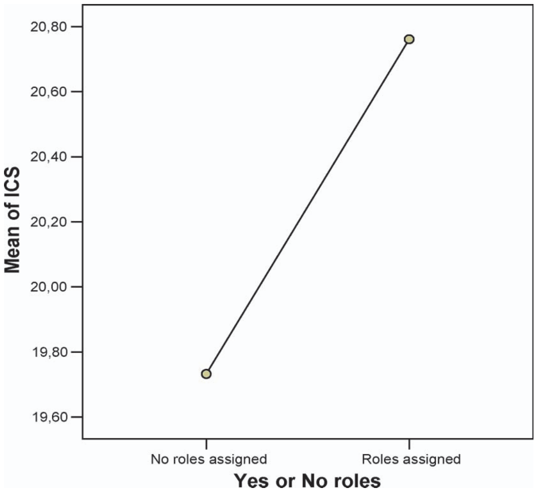

Figure 2. Graphical representation of the impact of role assignment on ICS.

Hypothesis 3. The nature of the role assigned to students will result in significant differences in the average level of knowledge construction and/or ICS.

Results of a one-way ANOVA reveals significant differences in the average level of knowledge construction due to differences in the role [($F_{3,323}$) = 4.68, $p < .01$, $h_p^2 = .042$]. Partial η^2 points to a very small effect size. Post hoc analysis reveals that the summarizer differs significantly from the moderator and source researcher.

Secondly, the analysis results reflect a significant impact of the roles on the ICS [($F_{3,148}$) = 9.86, $p < .01$, $h_p^2 = .17$]. Partial η^2 points to a rather limited effect size. Post hoc analysis indicates that the question asker consistently performs significantly lower as compared with the other roles. There are no significant differences between the other roles.

The results are consistent with findings in the literature that types of role matter and might affect the cognitive processing capacities of students and their learning outcomes. In earlier studies the role of the summarizer especially was observed to have a large positive impact (Schellens, Van Keer, & Valcke, 2005). In Figure 3 we can observe the higher impact of this role on both dependent variables; yet not always significantly different from the other roles. The present finding is important for developers of learning environments. Although in the literature role assignment is presented as an effective structuring approach in CSCLE, certain roles might distract learners from the central objective of the learning task at hand. We can assume that students adopting the role of question asker focus to a too large extent on the contribution of other students and neglect the elaboration of contributions to the discussions that are beneficial in attaining the learning objectives (De Wever, Van Winckel, & Valcke, in press). In the latter study it was found that students who, in the context of solving paediatric cases, were asked to look for alternative approaches showed higher levels of cognitive processing. This is explained by the fact that this role obliges students to adopt a broader perspective when looking at the other contributions in a discussion. They have to go beyond what is currently available.

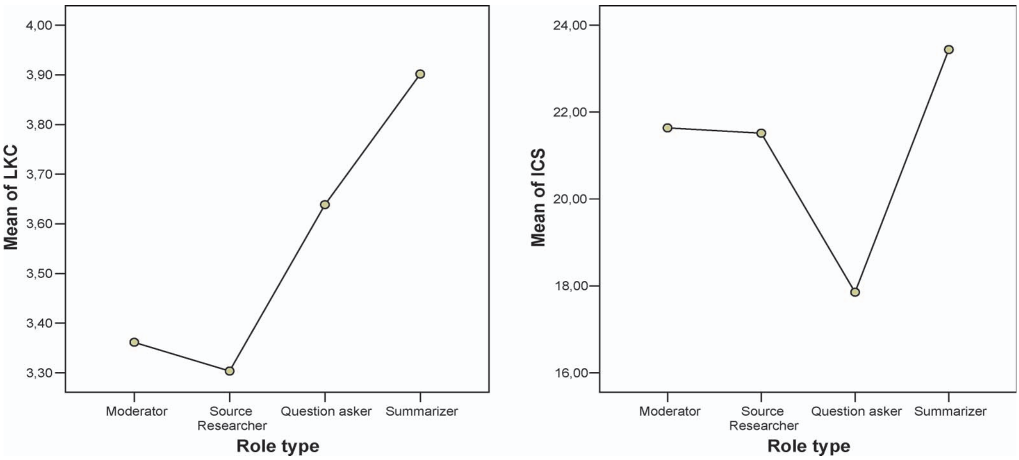

Figure 3. Graphical representation of the impact of role types on LKC and ICS.

Discussion and conclusions

The aim of the present article was to evaluate the impact of an innovative instructional design of internships in the context of a new integrated pharmaceutical curriculum. A key element in the innovation was implementation of a computer-supported collaborative learning environment. Students were, as part of their formal curriculum, expected to work in a systematic and collaborative way in discussing and solving real-life cases. Students in the role condition were assigned specific roles. The cases were an additional critical variable in the study.

The results of the study demonstrate that both independent variables, role assignment and cases, have a significant impact, especially on attainment of the objectives of the new integrated pharmaceutical curriculum.

However, despite these positive findings, some remarks have to be made. Firstly, the effect sizes of the significant differences are rather small. Secondly, and this can explain in part the former, the duration of the quasi-experimental design was short: 10 of 26 weeks of the internship. In addition, it was the first time that students had been involved in this particular way of working and learning. The researcher did not control for differences in prior knowledge about ICT. In addition, differences in the ICS can partly b explained by differences in prior knowledge of the part of the students. Future studies should control for these initial differences at the start of the study. Nevertheless, the fact that fifth year students were involved in the study can be put forward as an argument to stress to a lesser extent the potential impact of prior knowledge.

A short questionnaire was presented to the students to gather more qualitative information about their perceptions of the strong and weak points of the instructional set-up. Students stressed the following strengths of the approach: the fact that they had to use the Internet, the obligation to integrate knowledge from varying domains to tackle the cases, collaboration with other students, and the efficient technical tool. On the other hand, they reported the following negative or inhibiting factors: not all students had straightforward access to a computer and the Internet in their internship location, the additional workload, which became particularly obvious at the end of the internship period, the fact that they had to adopt a fixed role for all cases, and insufficient case information about the patients.

The results of the present study are promising. In the context of the pharmaceutical educational programme at the Ghent University these results have influenced the decision to implement the CSCLE in a structural way in the context of the internship period. Again, this instructional approach will be evaluated. At the same time the researchers will take into account the positives and weaknesses of the present study in developing and adopting sound and evidence-based instructional approaches in pharmacy education, as was argued by Beck (2002).

Notes on contributors

S. Timmers is a PhD student in the Faculty of Pharmaceutical Sciences of Ghent University (Belgium). Her research work focuses in the innovation of graduate education in the pharmaceutical field and centers on online learning, internship reform, and curriculum innovation.

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K. De Mil graduated as a master student in pharmaceutical sciences and was involved in the current study as part of her masters thesis research work.

W.R.G. Baeyens is professor in the department of Pharmaceutical Analysis in the Faculty of Pharmaceutical Sciences of Ghent University. Next to his pharmaceutical research focus, he is engaged in research about the innovation of pharmacy education.

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