The Impact of Computer Supported Collaborative Learning on Internship Outcomes of Pharmacy Students

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Abstract

The present 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

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Abstract

The present 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.

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**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 influence 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 by internship students.

**Integrated Pharmaceutical knowledge and curriculum reform**

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

In line with international trends, an evidence based approach and a competency based orientation of the curriculum have been adopted. The new integrated curriculum consist 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; and (3) pharmaceutical discipline related knowledge that comprises (a) chemistry, 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 program. 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 in two ways the way internships are now being set up. Firstly, 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. Secondly, 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 rheuma case, a severe persisting headache case and a hypertension case. Next to a description of the patient, the questions of the patient and information about the prescription by a GP, the students were presented with some guiding questions that question the nature of the prescription, the relevance of the medication, symptoms, argumentation to choose alternatives, etc. Each case was dealt with during 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. For instance, 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 this specific cases. This guaranteed the validity of the cases in view of the pharmaceutical curriculum and guided the assessment and evaluation of student input when discussing and solving the case.

The CSCLE implied that students had to collaborate online with other internship students to discuss and solve the pharmaceutical cases. It is hypothesized that the online collaboration fosters knowledge acquisition and competency development due to the explicitation 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 as a particular form of cooperative learning that – considering the extensive available empirical base – has proven to be beneficial on a large number of outcome parameters (Johnson & Johnson, 1994; Slavin, 1995). The approach can be compared to problem-based learning approaches where the key ingredients are: social and personal learning processes, learners’ shared experiences, responsibility, monitoring, and self-regulated learning (Stromso, Grottum & Hofgaard Lyck, 2004). This is in line with social constructivist assumptions about knowledge acquisition (Duffy & Jonassen, 1992, Schellens & Valcke, 2006; Salomon & Perkins, 1998, Stahl, 2004, 2005). Empirical evidence is available in the literature to support these assumptions (see for an overview Schellens, Van Keer & Valcke, in press). De Wever et al (in press) summarize five advantages of applying the computer supported collaborative learning approach: (1) students get opportunities to practice with information and communication technologies in the context of their professional training (Hagdrup, et al, 1999); (2) they are forced to keep up with the rapid growth in pharmaceutical knowledge; (3) the asynchronous nature of the 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); (4) asynchronous discussions provide students with time to reflect, think, and search for additional information before contributing to the discussion (Pena-Shaff & Nicholls, 2004) and (5) asynchronous discussion groups can be used to integrate clinical placements within the instructional design (Hagdrup, et al, 1999).
Despite the available empirical evidence about the impact of CSCLE, some authors also point at non-conclusive results of a number of studies (Archer, Garrison, Anderson, Rourke, 2001). Empirical studies about the impact of CSCLE have lead to the definition of design principles that are especially related to structuring the contributions of students. Especially 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 that launches the discussion and fosters the continuous active participation of other students in the group, (2) the question-asker that posts continuously critical questions and/or links questions to clarify contributions of other students, (3) the summarizer that is expected to submit summaries that clarify the outcomes of the discussions and the conclusions thus far and (4) a source researcher that backs up findings, statements, conclusions with references from the literature, research evidence, and other publications.

**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 to 8 students. Participation in the study was obligatory since the internship was a formal part of the study programme.

**Procedure**

Each of the ten groups studied and solved during two weeks a case. After two weeks a new case was presented. The first case was considered as a warming up case to get acquainted with the technology and the learning format. Data from this case were excluded from the analysis. To study the differential impact of role assignment, five groups were presented with roles and five group did not receive role assignments. The roles were assigned by the researchers to randomly chosen students within the role condition. Students were expected to post at least 4 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, next to a comparison of the impact on the dependent variables when discussing with or without roles. A second independent variable is related to the nature of the four cases. Since the cases differ in the extent they help to pursue subsets of specific curriculum objectives, this characteristic is considered as important to study the impact of CSCLE. Some authors point at the critical nature of the discussion themes or cases.
Task complexity has e.g., been detected to influence in a significant way a number of dependent variables (Schellens, et al., in press).

Two dependent variables are considered in this study. A first variable measures the extent to which student contributions to the discussions mirror the mastery of the learning objectives in relation to each case. Based on the prior analysis by a group of specialists, student contributions at theme level were evaluated by two independent researchers. This resulted in an Integrated Curriculum Score (ICS) for each student and each discussion. In view of further analyses, these ICS scores were standardized. In the CSCL literature, little research is available that studied thus far 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 & Veldhuis-Diermanse (2001) was adopted that distinguishes between 4 levels of task-oriented communication. It is hypothesized that students in the CSCL 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 three types of information:
   (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. Explicitation. 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 messages corresponds to a critical discussion of earlier information or ideas. Evaluation goes beyond a simple confirmation or negation and reflects argumentations, reasoning, justifications, for example “I can not 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 input of all 77 students in the four discussions were taken as the base for analysis. Since the first case was considered as a try-out, the data of this case were excluded from the analysis. Each complete message of a student was considered as a unit of analysis for the 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 &
Veldhuis-Diermanse (2001) at the level of each discussion and for each individual student. In view of calculating the impact on ICS, two groups in the role condition and two groups in the non-role condition were randomly selected. The transcript of these discussions - a total of 639 messages - were analysed in view of calculating an Integrated Curriculum Score (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 Integrated Curriculum Scores (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 are 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. Between brackets we report the number of messages in each cell.

<table>
<thead>
<tr>
<th>Case</th>
<th>Average LKC</th>
<th>Average ICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cases</td>
<td>3.46</td>
<td>20.71</td>
</tr>
<tr>
<td>Impetigo</td>
<td>3.58</td>
<td>23.96</td>
</tr>
<tr>
<td>Tooth extraction</td>
<td>3.52</td>
<td>21.33</td>
</tr>
<tr>
<td>Rheuma</td>
<td>3.34</td>
<td>20.47</td>
</tr>
<tr>
<td>Severe headache</td>
<td>3.40</td>
<td>18.78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case</th>
<th>Average LKC</th>
<th>Average ICSa</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cases</td>
<td>(1466)</td>
<td>(639)</td>
</tr>
<tr>
<td>Impetigo</td>
<td>(378)</td>
<td>(97)</td>
</tr>
<tr>
<td>Tooth extraction</td>
<td>(337)</td>
<td>(163)</td>
</tr>
<tr>
<td>Rheuma</td>
<td>(414)</td>
<td>(186)</td>
</tr>
<tr>
<td>Severe headache</td>
<td>(337)</td>
<td>(193)</td>
</tr>
</tbody>
</table>

*Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases
Table 2 mirrors the impact role assignment and types of roles on the dependent variables: the average level of knowledge construction (LKS) obtained by the population and the average ICS score obtained in relation to the four cases. Between brackets, we report the number of messages in each cell.

<table>
<thead>
<tr>
<th></th>
<th>No roles</th>
<th>Roles</th>
<th>Different roles</th>
<th>summarizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>moderator</td>
<td>source</td>
<td>question-asker</td>
</tr>
<tr>
<td>Average</td>
<td>3.47</td>
<td>3.44</td>
<td>3.36</td>
<td>3.30</td>
</tr>
<tr>
<td>LKC</td>
<td>(871)</td>
<td>(595)</td>
<td>(94)</td>
<td>(79)</td>
</tr>
<tr>
<td>Average</td>
<td>20.17</td>
<td>21.49</td>
<td>21.74</td>
<td>21.51</td>
</tr>
<tr>
<td>ICS(a)</td>
<td>(406)</td>
<td>(287)</td>
<td>(48)</td>
<td>(32)</td>
</tr>
</tbody>
</table>

a Integrated Curriculum Scores have been standardized to facilitate comparison between discussion cases
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 The total of messages does not equal the Role total of since not all students in the role condition were assigned a role.

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

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 oneway analysis of variance do reveal significant differences in the average level of knowledge construction due differences in the cases \(F_{3,1462} = 3.052, p = 0.028, \eta^2 = .006\). Partial eta squared points at a rather small effect size. Post hoc analysis reveals that in fact only the Rheuma case differs marginally significantly \((p=.055)\) from the Impetigo case.

Secondly, the analysis results reflect a significant impact of the different cases on the Integrated Curriculum Score \(F_{3,635} = 41.89, p < 0.01, \eta^2 = .17\). Partial eta squared points again at a rather small effect size. Post hoc analysis indicates that all cases differ significantly from one another as to their impact on the Integrated Curriculum Score. 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 findings of other authors that point at 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 lower level of prior knowledge about e.g., rheuma or severe head aches. 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 to 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 Integrated Curriculum Scores (ICS) and/or an average higher level of knowledge construction.

Independent samples t-tests indicate that there are no significant differences in knowledge construction observed when comparing groups with or without role assignment: \( t = 0.234, p = 0.815 \). These results are not in line with our expectation but do reflect comparable negative 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 did also receive a lot of guidelines that did sufficiently guide them in discussing and solving the cases. The large 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 Integrated Curriculum Scores point at a significant difference: \( t = -2.92, p < .01 \). Figure 2 represents the differences in a clear way.
As stated earlier, there is little research evidence available that focused thus far 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 can arise whether the impact of role assignment is still significant when considering the interaction with the cases as independent variable. Additional multivariate analysis of variance (Wilk’s Lambda) still points at a significant effect of roles x cases on ICS: ($F_{4} = 3.053, p < 0.01, h_{p}^2 = .014$). But is to be stressed that the effect size is rather small.

**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 oneway analysis of variance reveal significant differences in the average level of knowledge construction due to differences in the role ($F_{3,323} = 4.68, p < 0.01, h_{p}^2 = .042$). Partial eta squared points at a very small effect size. Post hoc analysis reveals that the summarizer significantly differs from the moderator and source researcher. Secondly, the analysis results reflects a significant impact of the roles on the Integrated Curriculum Score ($F_{3,148} = 9.86, p < 0.01, h_{p}^2 = .17$). Partial eta squared points at a rather limited effect size. Post hoc analysis indicates that the question asker consistently performs significantly lower as compared to the other roles. There are no significant differences between the other roles.
The results are consistent with findings in the literature that types of roles do matter and might affect the cognitive processing capacities of students and their learning outcomes. In earlier studies, especially the role of the summarizer 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; but 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 contributions of other students and neglect their personal elaboration of contributions to the discussions that are beneficial for attaining the learning objectives (De Wever, Van Winckel & Valcke, in press). In the latter study it was found that students that – in the context of solving paediatrics cases – were asked to look for alternative approaches, mirrored higher levels of cognitive processing. This was explained by referring to the fact that this role obliges students to adopt a broader perspective when looking at all the other contributions in a discussion. They have to go beyond what is currently available.

Discussion and conclusions

The aim of the present article was to evaluate the impact of an innovative instructional design of internships in view of a new integrated pharmaceutical curriculum. A key element in the innovation 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, but modest impact, especially on the attainment of objectives of the new integrated pharmaceutical curriculum (ICS).
But 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 out of 26 weeks of the internship. In addition, it was the first time that students were involved in this particular way of working and learning. The researcher did not control for differences in prior knowledge about information and communication technologies. In addition, differences in the ICS can partly be explained by differences in prior knowledge 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 expect a weaker potential impact of prior knowledge.

A questionnaire was presented to the students to gather some qualitative information about their perception of the strong and weak points of the innovative instructional set up. Students stress the following strengths of the approach: the fact they have to use the Internet, the obligation to integrate knowledge from varying domains to tackle the cases, the collaboration with other students and the efficient technical collaboration tool. On the other hand, they report the following negative or inhibiting factors: not all students had straightforward access to a computer and the internet in their internship location, they point at the additional workload that became especially obvious at the end of the internship period, some students in the role condition criticized the fact that they had to adopt a fixed role for all cases and some students would have preferred to receive more case information about the patients.

The results of the present study are promising. In the context of the pharmaceutical educational program of the Ghent University, these results have already 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 remarks of the students and the weaknesses observed of the present study in view of developing and adopting sound and evidence-based instructional approaches in pharmacy education as was argued by Beck (2002).

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