INTRODUCTION

Students in the doctor of pharmacy program at the University of Minnesota College of Pharmacy progress through a 5-semester sequence of learning activities in the Pharmaceutical Care Learning Center. This 5-semester sequence of coursework focuses on the development of students’ patient care skills. Much of the first 3 semesters of the 5-semester sequence focuses on the initial assessment of a new patient and development of an initial care plan. While this emphasis on the initial patient interaction is important, it is equally important to teach students how to follow-up with patients, determine the status of previously identified therapeutic problems, and address any new or unresolved therapeutic problems.1,2 At the same time students need to be exposed to patient follow-up situations involving multiple providers rather than a single provider, as this is a more realistic simulation of the health care system encountered in actual practice.3,4 Thus, the focus of patient care activities in Pharmaceutical Care Laboratory IV, the fourth semester of the Learning Center, was switched exclusively to simulated follow-up interactions.

One large obstacle in the development of learning activities simulating patient follow-up was the lack of an education-focused patient care documentation system and an integrated evaluation system. A search of the health care educational literature did not reveal any descriptions of such a system, nor did the search reveal substantial information regarding how documentation of simulated patient care activities are managed and evaluated in general.

Documentation systems used in actual health care settings could be used in an educational setting as they provide “real-life” documentation experience for students. However, such systems present 3 significant drawbacks: (1) they are not designed for educational purposes and therefore do not have an integrated efficient scoring and feedback mechanism; (2) they are not designed to work in “simulated time,” which is necessary when conducting multiple follow-ups; and (3) if the system is notably complex, it may inadvertently focus the learning on how and what to document in the specific system rather than simply how and what to document in general. Paper-based systems would trade the drawbacks outlined above for the absolutely overwhelming task of managing the paper shuffle associated with follow-up activities. A custom-developed Internet-based medical chart (IMC) for documentation and evaluation of simulated patient care activities could be designed to provide an integrated documenta-
DESIGN
Design of Learning Activities

Each student in the course met in the Learning Center weekly for 13 weeks of learning activities. The first of these classes was an introductory session and the remaining 12 were instructional and assessment activities. Of these 12 sessions, 4 were devoted to non-sterile compounding and 3 to sterile compounding, and the remaining 5 focused on developing clinical patient care follow-up skills. Table 1 summarizes the conditions covered in the 5 simulated patient care follow-up activities, along with the complexity (number of problems) of the associated cases. The conditions and complexity changed to allow for comorbid disease progression in activities 1 through 3 and to increase expectations and independence of students’ work by the end of the semester. The concurrent pharmacotherapy course largely focused on cardiovascular pharmacotherapy, and the simulated patient care learning activities reflected this emphasis. In activities 1, 2, and 3, students worked in pairs to review previous SOAP (Subjective/Objective, Assessment, and Plan) note documentation from simulated provider(s) in the IMC system, complete a follow-up interview and assessment of the simulated patient, develop the care plan, deliver the care plan to the patient including providing necessary education, and document the simulated patient care activities in a SOAP note in the IMC system. On activities 1 and 2, instructors provided occasional general therapeutic guidance without giving specific recommendations prior to documentation, but gave no assistance once students began documenting their activity. On activity 3, instructors provided specific assistance with the development of the care plan prior to documentation, as this case was the students’ first exposure to managing warfarin. In activities 4 and 5, students worked individually to review 1 or 2 previously completed SOAP notes from simulated provider(s) as well as the new background, subjective, and objective data for that day for a simulated patient in the IMC system; develop a care plan and complete the assessment and plan portions of the new SOAP note; and deliver the care plan to a simulated patient, including providing education as necessary. On activities 4 and 5, no therapeutic assistance was provided whatsoever before or during documentation.

All of the activities utilized live actors to simulate patients and use of and documentation in the IMC system was only part of the students’ assigned simulated patient care activities. The IMC system did not replace the personal interactions with patients that are vital to developing sound verbal and non-verbal communication and follow-up skills.

Objectives and Functionality

Once the projected use of the IMC system was defined within the overall structure of the learning activities, the IMC system’s core objectives were outlined. These core objectives were to (1) serve as a medical chart for documentation of multiple simulated encounters for a given simulated patient, (2) manage note entry dates to allow for simulated elapsed time between entries, which was different than actual elapsed time, (3) foster development of documentation skills and clinical decision-making, (4) optimize the quality and timeliness of feedback to students, and (5) minimize administrative workload of documentation and feedback activities. The system needed to meet 4 distinct but interrelated medical chart functions: (1) archive student and simulated provider SOAP note entries; (2) entry of SOAP note documentation of interaction with the simulated patient, (3) revision of student’s unsatisfactory SOAP entries, and (4) completion of “Finish the SOAP Note” activities (ie, student finishes Assessment and Plan given instructor’s Subjective/Objective data). In addition, the system needed to have the following feedback functionality: provide online rubric for instructors’ evaluations of SOAP note documentation, require instructors to enter explanation for every assigned “needs improvement” rating, and archive feedback in a manner that would foster later analysis of student and instructional performance.

Table 1. Simulated Patient Care Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Topic</th>
<th>Complexity: Conditions and Number of Problems</th>
</tr>
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<tbody>
<tr>
<td>1*</td>
<td>Lipids and blood pressure I</td>
<td>Hyperlipidemia and hypertension; 2 problems</td>
</tr>
<tr>
<td>2††</td>
<td>Coronary artery disease (CAD)</td>
<td>CAD, HTN, and hyperlipidemia; 3 problems</td>
</tr>
<tr>
<td>3††</td>
<td>Anticoagulation</td>
<td>Atrial fibrillation, CAD, HTN, and hyperlipidemia; 2 problems</td>
</tr>
<tr>
<td>4*</td>
<td>Lipids and blood pressure II</td>
<td>Hyperlipidemia and hypertension; 4 problems</td>
</tr>
<tr>
<td>5*</td>
<td>Lipids and blood pressure III</td>
<td>Hyperlipidemia and hypertension; 4 problems</td>
</tr>
</tbody>
</table>

*Emphasized following up on simulated provider’s previous visit(s).
†Second time student worked with patient (patient from weeks 2-3).
‡Third time student worked with patient (patient from weeks 4-5).
IMC System Development

To function, the IMC system required 4 components: a database, dynamic Web-page skeletons, a server, and computers with Internet access. A Microsoft Access database was developed to hold: (1) student pairings, scheduling, and other administrative information, (2) simulated patient demographic data, (3) instructor-entered SOAP note documentation of simulated provider-patient interactions, (4) students’ SOAP entries, and (5) instructors’ evaluations of students’ entries. Twelve dynamic Web-page skeletons were created in Macromedia Dreamweaver MX. These dynamic Web-page skeletons and the database were placed on a server running Macromedia ColdFusion. Each time a user (student or instructor) interacted with the IMC system through a standard computer with Internet access and browser software (Microsoft Internet Explorer or Netscape Navigator), the server custom-created the requested Web pages “dynamically” using the database, user-specific information, and the conditional coding of the dynamic Web-page skeletons (Figure 1).

Functions of the IMC System

Login access. The IMC system identified users and subsequently controlled access and security through a login Web page. There were 3 types of users: students, simulated providers, and answer keys. Login required a user name and unique password.

Reviewing previous SOAP note entries. After logging into the system, a student or simulated provider selected a patient and the chart view page loaded showing the patient’s chart (Figure 2). If the user was a student, the list of SOAP notes in the chart was custom-created to include only the patient’s notes authored or coauthored by the individual student or the simulated providers, Mary Conner, MD and Michael C. Brown, PharmD. Other students’ notes and the answer key entry(s) were suppressed from the chart’s listed note entries.

Entering a new SOAP note. To enter a new SOAP note, a student clicked on the “Enter a New SOAP Note” button (Figure 2), and the SOAP note template loaded (Figure 3). The student completed the required components of the note and submitted the note to the permanent record using his or her personal electronic signature. The Chart View page then reloaded with the newest SOAP entry appearing as a permanent addition to the patient’s chart.

Evaluation of the SOAP note. An instructor evaluated the student’s SOAP entry through the IMC system from a computer with Internet access. After logging in, an instructor (resident or graduate student) was shown a list of students assigned to him or her with links to any notes that needed evaluating. An instructor selected a link and the page loaded, displaying the student’s note and an evaluation rubric (Figure 4). Using the rubric (displayed in full in Table 2) in the IMC system, an instructor evaluated the components of background...
information (allergies, condition list, medication list, allergies/adverse drug reactions, and alcohol/tobacco/caffeine), subjective and objective data, assessment, and plan, assigning the ratings of exceptional (EX), satisfactory (SA), or needs improvement (NI) as dictated by the rubric. The IMC system required the instructor to type in comments when an NI rating was given for any single component; otherwise, comments were optional. Once the instructor submitted the evaluation, it was recorded in the database and automatically e-mailed to all coauthors, the instructor, and the course director (MCB).

Revise previous SOAP note. In situations where an instructor rated the SOAP note as needing significant improvement (assigning a “needs improvement” rating to 2 or more sections of the note), a student had the opportunity to revise the note by selecting an “Educational Tool: Revise Current Note” button (not shown in Figures). The student modified the selected SOAP note and resubmitted it for evaluation. The revised and original notes were retained in the patient’s chart for comparison, as were the respective evaluations.

“Finish the SOAP note” activity. In activities 4 and 5, students were asked to document only the assessment and plan portion of the SOAP note when given the background, subjective, and objective data. The SOAP note entry page would open, but the initial sections before assessment and plan were already propagated with an instructor-selected case. The student had to complete the assessment and plan and submit the note for evaluation as previously described.

Recovering partial SOAP entries. All SOAP notes were saved automatically outside of the permanent record as they were entered into the system. If the student or instructor inadvertently closed the browser without permanently submitting the document, it was available the next time the student(s) or instructor entered the system and selected the given patient’s chart.

Training for Use of the IMC System

Instructors were trained to use the IMC system for evaluating students’ entries during their usual meetings with the course director that occurred every 2 weeks. Technical aspects regarding the use of the system required minimal training. The majority of training time focused on reviewing and discussing cases, the answer keys, the evaluation rubric, acceptable approaches to the cases that may not perfectly match the answer keys, previous weeks’ challenges with leading and teaching in the activity, and areas to emphasize in instruction.

Students were trained to use the IMC system in 2 phases. First, they attended a lecture in the fall semester that introduced them to SOAP documentation and the IMC system. At this lecture they were also given a copy of the rubric evaluation criteria (Table 2). Second, students used the system once in the fall semester to document an initial simulated patient interaction and care plan. The course director and instructors provided proactive technical and educational support throughout this initial use of the system. For all activities in the spring semester (Table 1), instructors and the course director were present to provide technical assistance if necessary during activities (ie, help with logging in, navigating within the chart).

Analysis of Performance

Overall performance was summarized for each SOAP documentation as the percent of students demonstrating excellent performance (defined as receiving at least 1 EX and no NI ratings), satisfactory performance (only SA ratings), and substandard performance (1 or more NI rating). Only ratings for assessment and plan were included in the summary of all 5 activities because activities 4 and 5 were “Finish the Note” activities and did not have student-entered background, subjective, or objective sections. Although it would have been tempting to complete a classic “last note versus first note” comparison of the students’ performance in documentation, it was felt a priori that this would be misleading regardless of outcome, as the number and complexity of conditions and/or therapeutic problems increased throughout the semester, the group sizes did not stay the same, and the amount of instructor involvement prior to documentation purposely varied during the semester (Table 1). However, it was appropriate to compare the last 2 activities, because while they used different cases, they were of similar complexity and design (Table 1). For this analysis, differences in student performance for both excellent and substandard performance were analyzed using the McNemar test for paired categorical data. Of comparable educational interest was the
description and frequency of common errors resulting in NI ratings. At the end of the semester, the instructors’ comments to the students were analyzed by the course coordinator (MCB) to categorize the precise reason(s) for the NI ratings. These data were then used to determine the frequency with which students were able to learn from their previous mistakes and avoid making the same error(s) on subsequent activities. The timeliness and quantity of feedback was also analyzed to determine whether the IMC system met its desired functionality related to feedback.

**ASSESSMENT**

A total of 333 notes were entered into the IMC system by 98 students in the 5 activities of the semester: 46 for activity 1, 47 for activity 2, 44 for activity 3, and 98 each for activities 4 and 5. The numbers of student groups, and therefore number of notes, varied slightly on activities 1 through 3 because up to 3 students had to switch and/or combine groups due to illness and rescheduling.

**Overall Educational Performance**

Student performance on the group and individual SOAP activities is summarized in Table 3. Comparing activities 1 and 2, the percent of students with excellent performance stayed relatively constant, but the percent of students with substandard performance almost doubled as the complexity of the simulated patient scenarios increased. Activity 3 had both the highest percent of excellent performance and the lowest percent of substandard performance, but this coincided with a purposeful increase in instructor guidance on anticoagulation management prior to documentation as noted previously. Activity 4 performance showed the largest percent of students demonstrating substandard performance and the lowest percent of students demonstrating excellent performance, which coincided with a change from group to individual activities, an educational adjustment back to non-assisted therapeutic decisions, and an increase in the number of problems in the simulated patient scenarios. As previously mentioned, activities 4 and 5 were the only activities to

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**Table 2. SOAP Note Evaluation Rubric**

<table>
<thead>
<tr>
<th>Component</th>
<th>Needs Improvement (NI)</th>
<th>Satisfactory (SA)</th>
<th>Exceptional (EX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background Information</td>
<td>Information is inaccurate OR Information has major omissions that would make it unlikely another provider would come to the same A and P.</td>
<td>All information provided is accurate but minor omissions are made.</td>
<td>Information is complete and accurate in every detail.</td>
</tr>
<tr>
<td>Subjective/Objective</td>
<td>S/O is inaccurate OR S/O has major omissions that would make it unlikely another provider would come to the same A and P.</td>
<td>S/O is accurate but minor omissions are made.</td>
<td>S/O is complete and accurate in every detail.</td>
</tr>
<tr>
<td>Assessment</td>
<td>Assessment is missing goals OR has missing/wrong problem stated OR is inconsistent with established guidelines w/o explanation OR is otherwise clinically inappropriate OR has major omission that would make it unlikely another provider would come to the same Plan.</td>
<td>Assessment is appropriate but minor omissions are made OR assessment contains the Plan.</td>
<td>Assessment is complete and accurate in every detail.</td>
</tr>
<tr>
<td>Plan</td>
<td>Plan is missing specific recommendations (drug/dose/frequency) OR is not consistent with the Assessment OR is inconsistent with established guidelines w/o explanation OR is otherwise clinically inappropriate OR is missing Follow-up (what and when).</td>
<td>Plan is appropriate but has minor omissions OR Plan contains further Assessment information.</td>
<td>Plan is complete and appropriate in every detail.</td>
</tr>
</tbody>
</table>

*SOAP=Subjective/Objective, Assessment, and Plan*
warrant statistical comparison as they were the only 2 of similar complexity and design. Compared to activity 4, activity 5 showed a 161% increase in the percent of students demonstrating excellent performance (13.3% vs 34.7%, \(p<0.001\)) and a 41.6% decrease in substandard performance (73.5% vs 42.9%, \(p<0.001\)).

### Performance on Each SOAP Component

As a class, the students performed best on the background section of the SOAP notes. On the 137 notes on which students needed to complete the background section, 88 (64.2%) notes received an EX rating on the background section, 43 (31.4%) received SA, and only 6 (4.4%) received NI. The number of subjective/objective sections receiving EX, SA, and NI ratings were 41 (29.9%), 80 (58.4%), and 16 (11.7%), respectively. The assessment and plan sections clearly presented a bigger challenge. On the 333 assessments, 89 (26.7%) were rated EX, 146 (43.8%) were rated SA, and 98 (29.4%) were rated NI. For the plans, the number receiving EX, SA, and NI ratings were 56 (16.8%), 179 (53.8%), and 98 (29.4%), respectively.

### Types and Frequency of Errors

Of the 333 SOAP notes, 171 (51.4%) received an NI rating on 1 or more components. A total of 218 components were rated as NI, and the mean number of NI ratings per note for notes receiving at least 1 NI rating was 1.27. These 218 components and their corresponding instructor comments were examined to describe and quantify the types of error(s) that led to the NI ratings, and the results are shown in Table 4. A total of 362 errors or omissions on 218 components rated as NI in 171 notes. The mean number of errors per component rated NI for activity 4 was 1.89 (range 1-4, median 2). For activity 5, the mean decreased to 1.51 (range 1-3, median 1), which was significantly different statistically (\(p=0.003\)). Missing or incomplete follow-up documentation (laboratory and non-laboratory follow-up combined) was a major contributor to the NI ratings, accounting for 77 (21.3%) of all errors or omissions. Missing, incomplete, or inappropriate therapeutic goals were also a major contributor to substandard performance, accounting for 72 (19.9%) of all errors or omissions.
Learning from Previous Errors

Table 5 summarizes the number of students who received NI ratings on each given section of the SOAP notes, and then reports the number and percent of these students who avoided making the same error on any subsequent note and on the last SOAP note of the semester. Approximately 6 of every 10 students avoided making the same mistake on any subsequent activity for the remainder of the course. The percent of students repeating the same mistakes by the end of the semester was low, with no students repeating their previous mistakes on the background, subjective, and objective sections (activity 3), and only 6 (8.6%) and 10 (16.4%) students repeating their previous mistakes in the assessment and plan sections, respectively. Overall, only 12 of 88 (13.6%) students making one or more errors resulting in an NI rating repeated that mistake at the end of the semester.

Timeliness and Quantity of Feedback

A total of 308 (92.5%) of the 333 student entries met the feedback timeliness goal (student’s receipt of scoring and feedback prior to his or her next activity, or in the case of activity 5, at the end of the semester). A single note of the 333 did not get evaluated prior to the end of the semester, and this was a result of instructor and course coordinator miscommunication and not failure of the IMC system itself. The number of notes for each activity that met the timeliness of scoring and feedback goal, which continued to improve throughout the semester, is shown in Table 6. Table 6 also summarizes the median number of words provided as comments on the notes for each activity. The fewest comments were provided on the anticoagulation activity, which was the only activity for which specific therapeutic plans were discussed prior to documentation. Activity 4 had the highest median number of words in the comments section, and this is the activity on which the students performed least well as a whole. Evaluators always provided comments when they gave an NI rating (since the system required this for submission) and almost always provided some typed comments regardless of the rating given. Only 2 notes received no typed comments and in both cases all components were rated as EX.

Instructor and Student Acceptance

The IMC system functioned well, with no learning activities cancelled and only 1 day of 1 activity delayed by 5 minutes due to system performance. Instructor acceptance was not formally polled, but informal comments were very positive. Specifically, instructors mentioned that the freedom from transporting stacks of papers to and from class and the convenience of accessing the Internet from their office or home made the system superior to paper-based documentation.

Students were surveyed at the end of the semester as part of the usual end-of-course evaluation process. As with other evaluated components of the course, students could choose whether to attend and complete the surveys. Forty-four of the 98 students elected to attend this course session and complete the IMC evaluation survey. The number of respondents indicating an overall preference for the IMC system based on their previous experience with paper-based systems was 42 (95.5%), with 1 student indicating no preference and 1 student preferring previous paper-based documentation experiences.
Specifically regarding ease of use, 40 (91%) preferred the IMC system, 3 (7%) were neutral, and 1 (2%) preferred paper-based. For improvement of documentation skills, 38 (86%) preferred IMC, 5 (11%) were neutral, and 1 (2%) preferred paper-based. For timely feedback, 30 (68%) preferred IMC, 12 (27%) were neutral, and 2 (5%) preferred paper-based. For useful feedback, 31 (71%) preferred IMC, 10 (23%) were neutral, and 3 (7%) preferred paper-based.

DISCUSSION

The IMC system was an educational and administrative success. The system met its objectives, serving as a simulated medical chart to the students, facilitating efficient feedback to students from instructors, archiving performance for future analysis, and easing the administrative and logistical workload associated with all of these necessary functions. When comparing activities 4 and 5, the significant increase in the percent of students demonstrating excellent performance and the significant decrease in the percent demonstrating substandard performance were positive indications of the system’s effectiveness facilitating instruction and feedback. Unfortunately, these results were significantly tempered by the high percent of students receiving substandard ratings on these 2 activities. However, the system was clearly beneficial, both because it clearly facilitated students’ learning from previous mistakes and it provided a mechanism for identifying common class-wide problems that could then be addressed. In addition, the identified challenges in student performance likely exist at other institutions. Dissemination of these challenges may assist other institutions’ instructional approach, extending the benefits of the scholarship generated from the IMC system. Administratively, the system provided a flexible system for instructor feedback and eliminated the paper shuffle associated with traditional systems. It virtually eliminated the chance of lost notes or feedback by duplicating feedback documentation through use of direct data entry into a central database and automated e-mails. It also provided a mechanism that assured feedback was always provided for the poorest performance, eliminating the problem of students receiving poor scores without an explanation.

A comparison of the IMC system’s performance, educationally or administratively, to a previous system is not possible. A search of the literature finds no reports of similar simulated patient documentation or evaluation efforts of this nature, either computer- or paper-based. Prior to the IMC system, the course did not have the capacity to track student performance or undertake follow-up activities of this scope or interconnectivity. The IMC system replaced literally thousands of hand-to-hand transfers of simulated notes, student notes, and instructor evaluations that could not have been managed in a paper-based or other electronic-based system with available resources. Because the IMC system was Internet-based, it made all the students’ simulated patients’ charts available for pre-laboratory or post-laboratory review from any location, maximizing availability and flexibility of the coursework while minimizing the challenges of maintaining a standard documentation system on an intranet or local site. The conditional programming of the Web page skeletons filtered not just each instructor’s access to notes and evaluations, but also each student’s access to the medical chart, strictly and predictably controlling exactly which notes and evaluations could and could not be seen. An analogous paper system would require either (1) separate patient charts for each of the 98 students, which would be extraordinarily cumbersome and inefficient, or (2) placement of all student notes for the same patient in 1 chart, which would compromise both the realism of the experience and potentially the individuality of the students’ therapeutic plans. Although one could imagine setting up an Internet-based course bulletin board to avoid the paper shuffle and provide similar Internet-based availability, such a system would neither simulate the medical chart nor seamlessly triage and integrate the student entries, the evaluation rubric, the student feedback, and the systematic data archiving in one system, thereby forfeiting much of the realism, efficiency, and usefulness of the system.

Challenges and Limitations

Despite the successes, the system did present some challenges and limitations. It demonstrated that an Internet-based system, with all of its convenience, does not guarantee 100% timely feedback from instructors to students. Early in the semester some delays were due to system errors; however, even after these issues were fixed, 3%-13% of students still did not receive feedback prior to their next documentation activity. This delay is a serious problem that needs to be rectified in order to provide an optimal learning opportunity for all students. It also demonstrated that although the majority of students learned from previous mistakes, too many students were still making other significant errors in clinical decision-making and/or documentation at the end of the semester. This is almost certainly influenced by the complexity of the cases and likely will improve as each student’s experience grows. On the other hand, many of the errors were related to omissions rather than inexperienced clinical
decisions, making it an area demanding more instructional attention. Lastly, the high number of nonrespondents on the course evaluation may temper the otherwise overwhelming preference respondents expressed for the IMC system over previous paper-based documentation systems.

Future Direction

The IMC system has demonstrated its usefulness as an educational and administrative tool in a single course. There are 2 distinct areas in which to concentrate future use and assessment. First, the challenges presented by students’ overall performance must be addressed. Specifically, this work showed that students learn from their own mistakes. Future instruction needs to help students learn from each other’s mistakes as well as historical challenges so that all students progress to optimal performance more efficiently. Second, the use of the system must be expanded beyond a single course. Opportunities for instruction and learning are reasonably finite within a single course, but grow significantly across multiple courses and years of the curriculum. The IMC system was designed with the flexibility to allow application in both teaching and non-teaching laboratory settings. Such application would increase the opportunities for student learning and performance assessment. The IMC system also has potential for implementation and assessment at other institutions, either running off of the same server or being placed on any server that has Macromedia Cold Fusion and Microsoft Access.

CONCLUSIONS

The IMC system provided a unique and powerful tool for developing and managing simulated patient care follow-up activities in a manner not previously attempted with classic paper-based or electronic-based documentation. Students’ and instructors’ acceptance of the system was good. The IMC system efficiently managed the documentation of and feedback regarding simulated patient care activities, provided a mechanism for measuring student performance, and identified challenging areas that require more instructional emphasis. Future work will focus on assessing the impact of instructional modifications aimed at addressing student challenges and improving student learning. Opportunities for implementation of the IMC system in other courses in the curriculum will also be actively pursued.

REFERENCES