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Alison F. Doubleday
University of Illinois at Chicago, adouble@uic.edu

Blase Brown
University of Illinois at Chicago, bpbrown@uic.edu

Philip A. Patston
University of Illinois at Chicago, patston@uic.edu

Pamela Jurgens-Toepke
Midwestern University, pjurge@midwestern.edu

Meaghan Driscoll Strotman
Univeristy of Illinois at Chicago, mdrisc3@uic.edu

See next page for additional authors

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Authors
Alison F. Doubleday, Blase Brown, Philip A. Patston, Pamela Jurgens-Toepke, Meaghan Driscoll Strotman, Anne Koerber, Colin Haley, Charlotte Briggs, and G. William Knight

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ARTICLE

Social Constructivism and Case-Writing for an Integrated Curriculum

Alison F. Doubleday, Blase Brown, Philip A. Patston (University of Illinois at Chicago), Pamela Jurgens-Toepke (Midwestern University), Meaghan Driscoll Strotman, Anne Koerber, Colin Haley (University of Illinois at Chicago), Charlotte Briggs (Bay Path University), G. William Knight (University of Illinois at Chicago)

Case-writing within an integrated, systems-based health professions education curriculum presents many unique challenges. Specifically, case-writing in this context must consider integration of multidisciplinary learning objectives and synthesis of biomedical and clinical sciences. Establishing an effective process for content integration and determining who should be involved in the case-writing process can be a daunting task and this specific context requires a new model for effective case-writing. This paper provides a model for the cycle of case development, implementation, evaluation and modification in an integrated, systems-based health professions curriculum. We highlight how this collaborative case-writing model parallels the social constructivist approach promoted by the problem-based learning process in which our students engage.

Keywords: case writing, integrated curriculum, problem-based learning, social constructivism, problem design, collaborative learning

Introduction

The design of problems for problem-based learning (PBL) contributes significantly to the effectiveness of the PBL process (Hung, 2009; Majoor, Schmidt, SnellenBalendong, & Stalenhoef-Halling, 1990). Results of several studies (Colsoun & Osborne, 1984; Dolmans, Gijselaers, Schmidt, & van der Meer, 1993; O'Neill, 2000; Van Gessel, Nendaz, Vermeulen, Junod, & Vu, 2003) have found a mismatch between learning issues generated by students and those developed by faculty, with only 60–64% of student learning issues, on average, corresponding to those generated by faculty during problem construction. Dolmans et al. (1993) argue that this asymmetry may be due to poor problem design. Hung (2009) outlines several ways in which PBL problems may be ineffective, including: (1) inappropriate content coverage, (2) inappropriate problem-solving requirements, and (3) unintended ambiguity of problems. Gijselaers and Schmidt (1990) stress the importance of cases in determining the quality of the PBL process and suggest that improvements to PBL outcomes can derive from efforts to improve case quality. Indeed, the purpose of cases in PBL is to scaffold the process of knowledge construction by providing a path for discovery.

The PBL literature includes studies investigating characteristics of effective cases (Edmondson, 1994; Harling & Misser, 1998; Hmelo-Silveres & Barrows, 2006; Jonassen, 2000; Jonassen & Hung, 2008), characteristics of cases in specific learning environments (Dabbagh & Dass, 2013), implementation of cases, (Albanese & Mitchell, 1993; Azer, Mclean, Onishi, Tagawa, & Scherpbier, 2013; Schmidt, Rotgans, & Yew, 2011), and perceptions of cases by students and facilitators (Sockalingam & Schmidt, 2011; Tamim & Grant, 2013). There is a scarcity of research investigating the process of case construction and how case-writers anticipate and plan for successful knowledge construction by students. As the quality of PBL problems can affect learning outcomes, it is essential to examine the process used for developing problems and cases. Just as student engagement during PBL impacts learning outcomes for the group, it is likely that the case-writing process impacts the effectiveness of PBL problems and cases.

Case-writing can be challenging in any environment, but is particularly so in integrated, systems-based curricula as these contexts preclude the use of discipline-specific cases and require integration of a broad base of knowledge. The purpose of this paper is to:

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- Describe the challenges and goals of writing integrated cases,
- Provide a model for integrated case development,
- Reveal case-writers' perceptions of the model,
- Compare the writing and small-group learning processes, and
- Provide recommendations for structuring an effective case-writing team.

The framework of social constructivism highlights how this model parallels the approach promoted by PBL. We assert that case-writing can be improved by embracing a social constructivist paradigm founded on a highly interactive process of dialogue, discovery, and conceptualization.

Social Constructivism as a Framework for Understanding the Learning Process

The constructivist framework underpinning PBL has been discussed extensively (Hendry, Frommer, & Walker, 1999; Honebein, Duffy, & Fishman, 1993; Savery & Duffy, 1995; Schmidt, van der Molen, Te Winkel, & Wijnen, 2009; Schmidt et al., 2011). Although it is multifaceted, constructivism posits that knowledge is constructed by human agents rather than being passively absorbed. Kemp (2011) emphasizes the importance of understanding the constructivist foundation of PBL because it "enables teachers to reflect on the goals of teaching, how the classroom is organized, and the pedagogical strategies and methods adopted to promote learning."

From a constructivist view, the learning process determines what is learned. Understanding is developed through a combination of learner activity, the learning environment, exposure to other constructs through social interactions, and the background and goals of the learner. Savery and Duffy (1995) point to Barrows's conception of PBL (1985, 1986) as a premiere example of constructivism in practice. Specifically, Savery and Duffy (1995) outline a set of instructional principles growing from constructivism, which are supported by the PBL learning environment. These principles include anchoring learning activities to a broader task, designing an authentic task reflecting the complexity of the professional environment for which students are being trained, and supporting the learner in developing ownership of the process. The learning environment should challenge the learner's thinking, thus providing alternative views and opportunities for reflection.

Within the umbrella of constructivism, Phillips (1997) discusses two schools of thought. Psychological constructivism, rooted in the work of Piaget (1977), focuses on the creation of meaning for an individual within a group setting. The individual is the unit of analysis and in whom a mental model is constructed. Social constructivism is more closely associated with the work of Vygotsky (1978) and proposes that "learners construct knowledge through discourse with other members of the community . . . . Learning is produced by the team" (Savin-Baden & Major, 2004). For social constructivism, knowledge is constructed by the group. Individual constructs are transformed as a result of group interaction, and the social context in which meaning is created is an essential contributor to the process.

There is debate about which form of constructivism (psychological or social) contributes most to student learning in PBL. In their review of the literature, Schmidt et al. (2011) argue that learning in PBL is a combination of both. This view is supported by Yew, Chng, and Schmidt (2011), who test the hypothesis that learning during PBL involves self-directed and collaborative learning. The authors asked 218 students to recall scientific concepts following each of three PBL phases (problem analysis, individual study, and reporting). Results demonstrated that achievement could not be predicted by either self-directed study or by collaborative work alone.

PBL relies heavily on group learning and encourages social interaction and collaboration. The importance of collaborative learning is also evident in the case-writing process. Below, we provide a model for case-writing that reflects the tenets of social constructivism and demonstrates how a collaborative approach can be implemented. We argue that social interactions are of paramount importance in crafting interdisciplinary cases and the influence of individual learning is less important.

Case-Writing for an Integrated Curriculum

In August 2011, our institution introduced a Doctor of Dental Medicine (DMD) degree. The associated curriculum encourages a holistic view of the patient and promotes content integration through an approach in which biomedical sciences for each organ system are addressed together.

Crawford et al. (2007) and Briggs, Patston, Knight, Alexander, and Norman (2013) outline the rationale for our curricular restructuring. In addition to eliminating marginally relevant material and redundancies in content, we wanted to create a learner-centered environment focused on learning outcomes and critical-thinking and problem-solving skills. The ability to examine a topic beyond the confines of discipline-specific frameworks is essential for health care professionals as they consider systemic causes and effects of disease.

Our institution's traditional curriculum is compared with the integrated curriculum in Table 1. In the traditional curriculum, one faculty member with content expertise developed content for a course. In some cases, lectures were supported with laboratory activities, but students were assessed through summative examinations only. In contrast, in the integrated curriculum, faculty teams contribute to content development, lectures are limited, and students spend six hours a week in small-group learning sessions. Students receive peer and faculty assessment and, in addition to summative assessments, students self-assess, engage in reflective writing assignments, and participate in formative assessments.

Table 1. Comparison of the traditional DDS and integrated DMD curricula.

	Traditional Curriculum (DDS—Doctor of Dental Surgery)	Integrated Curriculum (DMD—Doctor of Dental Medicine)
Curricular Focus	Teacher-centered	Learner-centered
Course structure	Discipline-based (e.g., anatomy, physiology, biochemistry)	Organ system-based (e.g., pulmonary, cardiovascular, musculoskeletal)
Content Delivery	Lectures	Small-group learning, supported with targeted lectures
Course Content Development	Conducted by individual faculty members for each course	Conducted by teams of faculty with varied disciplinary expertise, some laboratory content developed by individual faculty members
Laboratories	Dissection-based anatomy lab, slide and microscope-based histology lab	Dissection-based anatomy lab, slide and microscope-based histology lab
Assessments	Summative assessment	Peer-assessment, self-assessment, formative assessment of learning process, summative assessment

Figure 1. The process of small group learning (SGL) within the integrated curriculum.

Removing discipline-based barriers required that faculty members from different disciplines work together to integrate content across the curriculum. Cases for small-group learning were intended to prompt students to investigate topics across disciplines. As such, an interdisciplinary approach for case-writing was essential.

Small-Group Learning at Our Institution

Our institution is affiliated with a large, urban university. The entering dental student cohort (D1) consists of 50 students. Cases are the primary vehicle for learning and present a bridge between biomedical and clinical content. As recommended by Jonassen (1997, 2000), open-ended problems prompt students to exhaust their knowledge and create learning issues based on gaps in prior knowledge. We use a guided inquiry method and provide a degree of structure during sessions. Small-group learning at our institution differs from the definition of authentic PBL set forth by Barrows (1985) in that there is not always a solvable problem. As cases serve as the primary vehicle for learning, we view our pedagogy as within the broader tradition of PBL. The terms "small-group learning" or "case-based learning" (Srinivasan, Wilkes, Stevenson, Nguyen, & Slavin, 2007) most closely fit our activity. For the sake of simplicity, we will refer to small-group learning in our context as "SGL" throughout this paper.

Figure 1 describes our SGL process. Students explore two cases every five weeks. Each case requires three days of group activity, consisting of a three-hour discussion session per day. Student groups of 6–8 work with a faculty facilitator. On Day 1, groups explore prior knowledge. Students engage in self-directed learning between Days 1 and 2 and between Days 2 and 3. Day 2 involves reporting findings from self-directed study and further problem exploration. On Day 3, students report results of self-study, learning objectives are provided to students, and each group assesses its level of understanding. Groups also engage in self and peer assessment on Day 3.

A Model for Case-Writing in an Integrated Curriculum

To address the challenges of case-writing for an integrated curriculum, we implemented a cycle of (1) identification of discipline-based learning objectives, (2) case creation, (3)

case review, (4) case implementation and session-specific feedback, (5) post-case review, (6) case modification, and (7) modification of curricular activities.

Our model is similar to key steps presented by Hung (2009) and incorporates the 12 tips for case construction offered by Azer, Peterson, Guerrero, and Edgren (2012). Our model differs from Hung (2009) by specifically addressing the integration of multidisciplinary learning objectives. Azer et al. (2012) discuss the importance of disciplinary integration and blending of biomedical and clinical sciences. The authors provide helpful strategies for creating effective cases in this context but they do not discuss the processes of idea generation or case refinement. Our model contributes to the literature by investigating the following questions:

- How can a case-writing team develop learning objectives for interdisciplinary cases?
- Who should be part of the case-writing team?
- How can the team respond to feedback?
- How do cases integrate with and stimulate changes in curricular activities?

The Cycle for Case Development

The case development process for our first- and second-year (preclinical) courses is shown in Figure 2. Elements of this cycle persist in the third and fourth years. However, cases exhibit an increasingly clinical focus with student advancement, reflecting an increase in experiential and clinical activities in those years.

Identification of Discipline-Based Learning Objectives

Before implementation of the integrated curriculum, instructors in first-year, discipline-based courses developed a comprehensive set of learning objectives for each organ system. Case-writers, assessment experts, and course directors view learning objectives for organ systems across all disciplines (anatomy, histology, embryology, biochemistry, physiology, etc.) and use the objectives to create integrated cases and assessments. Examples of learning objectives can be found with the sample case in the appendix.

Case Creation by a Multidisciplinary Case-Writing Team

The case-writing team includes individuals with degrees in dentistry and clinical teaching experience, individuals with experience teaching biomedical sciences, and individuals trained in pedagogical methods. Examination of learning objectives across disciplines stimulates personal reflection that illuminates connections among objectives. The diverse backgrounds of case-writers play an important role in developing clinical scenarios and refining biomedical science objectives. All members of the case-writing team participate in facilitator training sessions and in other activities such as didactic, clinical, or laboratory sessions. Thus, they grasp the holistic view of the curriculum and align cases with other learning activities.

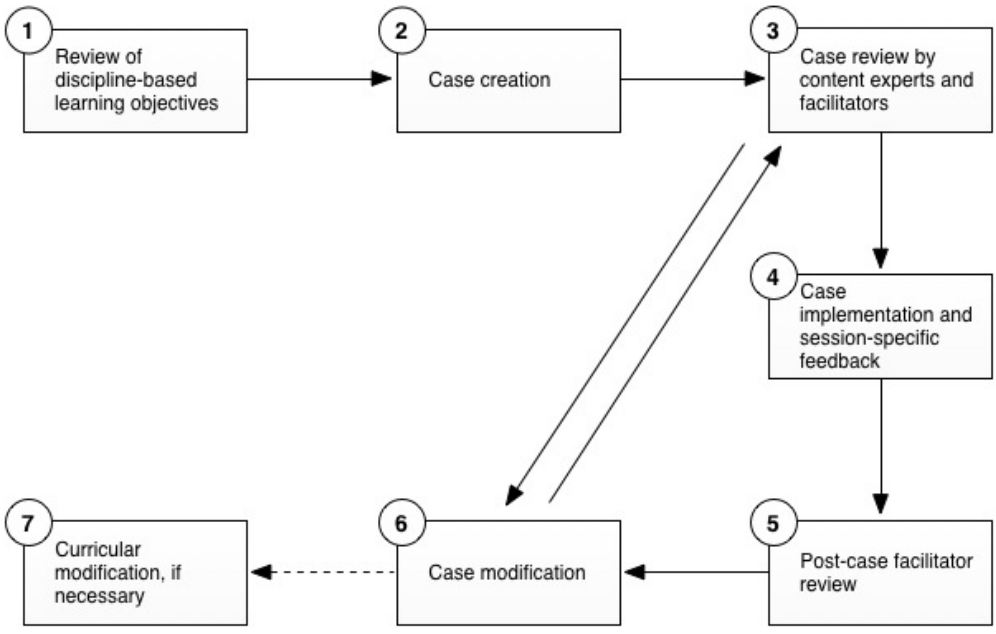

Figure 2. The case-writing process for an integrated systems-based curriculum. Case-writing begins with step 1 and progresses through step 7. After case modification (step 7), curricular changes may be made. The second iteration of case development begins after case modification and the cycle resumes by obtaining feedback through case review. At step 3, content expert and facilitator feedback can stimulate case modification. After modification, cases are always sent back for expert and facilitator review.

Case Review by Content Experts and Facilitators

Biomedical scientists, clinicians, and social scientists participate as content experts and facilitators. Content experts review the case to confirm the appropriateness and accuracy of information, refine learning objectives, and judge whether students are likely to investigate specific objectives based on the text. Facilitators review the case and identify areas that may prove challenging for students. Discussions are usually rich and ensure that student inquiry addresses appropriate content in each discipline. For example, an epidemiologist may suggest that a particular case lends itself well to discussions contrasting disease risk factors with health behaviors.

The varied expertise offered by group members can create tension, as these perspectives bring with them their own approaches and priorities regarding learning goals. It is essential that the case-writing team provide the larger group with information on case goals. The case-writing team must also be able to place the case within the context of the four-year curriculum, and discuss when and where certain objectives are addressed. Facilitators and content experts may provide feedback on any aspect of the curriculum and may identify discipline-specific learning objectives that have been overlooked or could be addressed more effectively. In response, case-writers modify the case and return it to content experts and facilitators for re before implementation.

Case Implementation and Session-Specific Feedback

After working through the case in SGL, facilitators and students have another opportunity to provide feedback to case-writers. Student groups record learning issues and post them to an online blog at the end of every SGL session. The blog allows facilitators and case-writers to see how students are progressing and which learning issues students identify based on their reading of the case text. Facilitator feedback is collected through a separate online blog that allows for sharing details about group experiences, and providing suggestions for improving the case or group function.

Post-Case Review by Facilitators

After case implementation, facilitators provide additional feedback. In a face-to-face meeting, facilitators discuss components of the case that did or did not work well. Facilitators may also use this time to solicit or provide advice about group function. All comments and suggestions are documented for future use by the case-writing team.

Case Modification

At the end of the year, the case-writing team convenes to modify cases based on the previous year's feedback. While initial changes were minor, over time, more comprehensive and substantial modifications have been needed to address issues indicated by students, facilitators, and content experts. For example, after our second year of curricular implementation, case-writers realized that a different sequence of organ systems would allow students to start off stronger and encounter more complex topics later, like the nervous system, after gaining a firmer foundation in the biomedical sciences. The case-writing team identified the need for reorganization because of the quality and specificity of feedback provided by content experts, facilitators, and students.

Modification of Other Curricular Activities

Many case-writing team members are involved in planning didactic and experiential laboratory sessions and thus can ensure close alignment among cases and these other activities. This proved particularly valuable when the organ system sequence was rearranged. The team was able to reorganize didactic sessions and laboratory topics as well as cases. The dissection laboratory was particularly challenging to reorder, as dissection requires a regional, rather than systemic, approach. Because the laboratory director is a member of the case-writing team, case-writers could include regional anatomy within a case dedicated to a particular organ system. For example, a case on the musculoskeletal system includes a dentist with a herniated cervical disc, allowing the case to remain systems-based yet align with dissections of the brachial plexus. A case sample, aligned with curricular activities, is included in the appendix.

A holistic approach to case modification is also used for incorporating clinical content. Meetings with dental science content experts provide opportunities to align didactic sessions and preclinical laboratory exercises with cases. Alignment is not always perfect and students occasionally encounter a topic in laboratory prior to SGL (or vice-versa), but encountering material in different contexts serves to reinforce learning.

Case-Writers' Perceptions of the Process

To understand case-writers' perceptions of the process and its influence on the case, eight case-writers (three male, five female) composed written narratives addressing these questions:

1. Describe the process of case-writing. How did the process develop; how has it changed over time?
2. What challenges do you face during case-writing?
3. What are the most effective aspects of the process?
4. Describe your thoughts and feelings about being a case-writer.

Three case-writers hold clinical degrees (DDS), three hold doctoral degrees in biomedical sciences or education, and two hold both clinical and graduate degrees. All case-writers have served as small-group facilitators and four routinely instruct in didactic or laboratory settings.

A qualitative study using open coding was employed to analyze the narratives and identify themes characterizing the case-writing process. All statements were coded. Codes were grouped into common categories and an iterative process was employed to consolidate similar categories into themes. Member checking was used to validate themes and interpretations. Seven themes were identified as common to facilitator descriptions of the case-writing process. Themes are listed in Table 2 and described in more detail below. Quotes illustrating each theme are included in Italics. ("CW#" refers to a specific case-writer.)

Theme 1: Background and Prior Knowledge

Activation of prior knowledge is an essential component of SGL (PBL) (Schmidt, 1993; Schmidt et al., 2011). Heterogeneity of the group provides access to varied experiences and is an important factor in a group's ability to activate prior knowledge. Likewise, our case-writing team consists of individuals with varied backgrounds and expertise, and personal experiences are often the impetus for case narratives:

> **CW8:** *[case-writing] starts as this person telling a story about something s/he experienced . . . and then we all brainstorm to find a dental application or relevant example. These stories allow us to identify tie-ins to other systems or to professionalism or dental topics. Even though we started out with learning objectives, the narrative was the driving force allowing us to pull many of these together into a story."*

Accessing prior knowledge is an important component of the case-writing process, and group interaction is essential for building a comprehensive picture of a problem. Additionally, writers understand that deficient prior knowledge in a particular discipline can diminish the effectiveness of the case and student learning. As group interaction among case-writers uncovers gaps in knowledge, it becomes necessary to find content experts to advocate for specific disciplines.

> **CW2:** *"We built some cases that were complicated medically but no faculty were currently lecturing on the material . . . . It was hard to assess student learning from these cases."*

Theme 2: Building Expertise and Self-Efficacy

During SGL, students gradually build confidence and self-efficacy. The same phenomenon occurs for the case-writing team. Members become increasingly aware of their limitations, as well as their acquisition of skills required for effective case-writing. Case-writer 1, a clinician, remarked on initial feelings of inadequacy:

> **CW1:** *"It was a humbling experience the first time we read through the case and I felt the need to defend why I wrote something a specific way . . . . I was insecure because I was more of a clinician and there were content*

Table 2. Factors influencing the effectiveness of the case-writing process, as identified in case-writer reflections.

Themes from Case-Writer Reflections	Definition
Background and prior knowledge	Knowledge stemming from previous experiences
Building expertise and self-efficacy	Accumulating personal experiences with success and failure and being able to make a judgment about one's own ability to perform a task (Bandura, 1982)
Self-regulation and feedback	Individuals take initiative, with or without the help of others, in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes (Knowles, 1975)
Cooperative vs. collaborative learning	Cooperative learning: individuals work together to achieve a common goal and to maximize each other's learning (Johnson & Johnson, 1999; McInnerney & Roberts, 2004); collaborative learning: social interaction is the primary means of building knowledge (McInnerney & Roberts, 2004).
Responsibility	Being accountable for an outcome.
Intrinsic motivation	Engaging in an activity because it is inherently interesting or enjoyable (Deci & Ryan, 1985)
Buy-in/ownership	Agency and choice of control over a task or outcome (Enghag & Niedderer, 2008)

experts with vast amounts of knowledge on the team . . . . I'm sure many students enter the room and see their new group members and experience the same feeling."

Case-writing experience builds individual as well as group confidence, which fuels a positive cycle of skill development. As case-writers exhibit a higher sense of self-efficacy they are better able to self-assess and to target skills that need to be developed:

CW3: *"It takes a lot of skill to write a case . . . we have to find a way of presenting information to students without just giving them the learning objectives or a bunch of student prompts."*

Theme 3: Self-Regulation and Feedback

SGL has a positive impact on student self-regulation, self-correction, and identification of misconceptions (Perry, VandeKamp, Mercer, & Nordby, 2002; Sungur & Tekkaya, 2010). The case-writing process has a similar impact on case-writers. Regular feedback improves self-regulatory skills and stimulates case changes. Case-writer 4, a biomedical scientist, notes that writing ability improves after feedback and leads to better cases:

CW4: *"The debriefings are essential even though they are tedious. The cases are now much tightened up, better written."*

The cycle of continuous feedback changes how case-writers view the curriculum. For those involved, the curriculum is ever-evolving and fluid:

CW3: *"If, after feedback, we find that an assignment or narrative doesn't function well, we are good about recognizing the issue and improving it . . . no case is ever done. For cases to continue to be effective they have to evolve to fit the changing needs of the student, curriculum, and profession."*

Theme 4: Cooperative vs. Collaborative Learning

One of the biggest challenges for the case-writing team is collaboration. Case-writing initially started as a cooperative effort, with team members taking on distinct responsibilities. In cooperative efforts, each person contributes a unique component to a shared learning goal, but meaning is not constructed through interaction with others. Group members benefit from work conducted by others, but they do not build their understanding from the combined experiences and interaction essential to collaborative learning (Bruffee, 1996; McInnerney & Roberts, 2004).

CW1: *"[Initially] each member of the team would take responsibility for writing a case. We had a topic but had to tease out which learning objectives were most relevant and make sure the case reflected those."*

This strategy, however, led to substantial rewriting of cases. All case-writers commented on the need for increased collaboration, interaction, and communication as part of the process. Instances where this need was not met led to challenges or tensions:

CW2: *"There has been some 'reinvention of the wheel' that could have been avoided had there been a more collaborative approach to the writing process."*

Currently, the case-writing team takes that more collaborative approach. Case-writing takes place during group meetings. One group member may take the lead, but all members contribute to discussions and research surrounding case ideas. Including more faculty members in the process has been the key to this endeavor:

CW5: *"Prior to SGL, a summary of each case is shared with all faculty and summaries of course plans for each week are shared with everyone. This enables all instructors to grasp the 'big picture' and the relevant connections among their parts . . . this prompts an array of collaborations across the teams to improve the sequence of their topics and design coordinated assignments."*

Collaborative learning is an important aspect of SGL, and the collaborative nature of case-writing allows writers to experience the SGL process while the case is developed. We believe this leads to a more authentic experience for students as many case-related challenges are anticipated.

Theme 5: Responsibility

One of the primary goals of SGL is for students to shoulder responsibility for learning (Quinlan, 2000). Within this learning environment, students also have a responsibility to their peers' learning. Case-writers noted similar feelings:

CW7: *"It's going to affect more people than I can imagine. Philosophically, just about everybody who comes here wants to help people. I'll have greater impact on patients doing this [case-writing] than I ever would on my own, as a health care provider. That's a motivating factor for me in being here and in writing the cases too."*

Case-writers also expressed frustration when confronted with the possibility of failing or falling short of these responsibilities:

CW8: *"I dislike the responsibility that comes with it—knowing that a mistake might mean ineffective learning for many."*

Theme 6: Intrinsic Motivation

The importance of situational interest and task engagement for students has been documented (Rotgans & Schmidt, 2012). Similarly, case-writers are motivated by their commitment to students, general enjoyment of the activity, and desire to expand prior knowledge:

> **CW7:** *"I found the whole process fascinating—not just coming up with a scenario but getting to think about the whole learning process . . . having learned all these things at one time or many times, and getting to think about them in a different way and looking at what I learned really well and what I still use and how I managed to make that connection. I've gotten to encounter things with patients for many years and I say—oh, I can't remember that and I go back and I read about it . . . . I look at the process we use in case-writing as the process I have repeated myself, in my life, and that is very stimulating."*

Theme 7: Buy-In and Ownership

Just as students may be skeptical of the value of SGL (Alessio, 2004; Biley, 1999; Nardi & Kremer, 2003; Seaberry, 2002), some faculty members are hesitant to support the case-writing process. Case-writers commented on the challenges this presented for case-writing. Recruiting faculty to participate in case-writing is dependent upon effective and transparent communication about the entire curriculum:

> **CW3:** *"Getting objectives to build a case around can be difficult, especially if content experts are not familiar with the process or don't see its value."*

> **CW2:** *"[initially] content experts were annoyed that we wrote their content into a case without involving them . . . . Our second iteration involved the content experts more directly."*

Because case-writers depend on faculty for expertise and feedback, they must convey the value of cases (and SGL) in the curriculum. Many faculty members are accustomed to directing their own content-specific courses, and an inclusive case-writing process can help eliminate feelings of loss of ownership over material.

Comparing Case-Writing and SGL Processes

Case-writers' narratives allude to ways in which case-writing mirrors learning processes that take place for students during SGL. In Figure 3, we compare the steps of our case-writing model with Barrows's four phases of PBL activity (Barrows, 1985), with steps for PBL identified by Schmidt (1983). Steps in each of these models are grouped into three categories. First, Category 1: (white circles) identifying, analyzing and defining the problem. Second, Category 2: (light gray circles) collecting outside information that refines current mental models. For case-writers, this includes obtaining feedback from content experts and facilitators; students seek knowledge and perspectives not encountered in the group through independent study. Finally, Category 3: (dark gray circles) synthesis of knowledge discovered through steps in Categories 1 and 2.

From a social constructivist perspective, Category 3 represents the culmination of the process and allows case-writers and students to construct a new mental model. Although the processes are similar for case-writers and students, case-writers are dependent upon group interactions while collecting outside information (Category 2: light gray circles). This comparison highlights how collaborative learning and social construction of meaning is foundational to both processes, and particularly so for case-writing.

Case-Writing as a Social Constructivist Activity

As we compare case-writing and SGL, placing the characteristics of these processes within the theoretical framework of social constructivism allows us to better understand how we conceive of the case-writing process and how factors case-writers value (e.g., collaborative activity, group heterogeneity, communication) impact the outcome of the activity. A common thread throughout case-writer narratives is the belief that the group's ability to construct meaning depends upon interaction of (1) prior knowledge, (2) ideas growing out of combined knowledge, and (3) discussion stimulated by the collective building and modification of these ideas. Case-writing is a collaborative activity and writers expressed a lack of confidence in being able to undertake the process as an individual effort.

Similarly, prior knowledge and self-directed learning play an important role in SGL, but learning is driven and constructed through group interactions. Students, collaboratively, build a mental model to explain a problem. Further interactions refine and modify this model. The result is more than the combination of individual perspectives, it is a product of the interaction of diverse constructs and cannot be separated from the context in which it was created. In case-writing, an integrated case is constructed through interactions of individuals with varied expertise and experiences. Although an anatomist can develop a case about the cervical spine and brachial plexus, only through interactions with individuals with clinical experience and broader biomedical science expertise can the case also address interprofessional communication, implications of an injury for a dentist, and the mechanism of action for specific pharmaceutical agents.

Figure 3. A comparison of steps in the case-writing cycle with steps or phases in problem-based learning.. Steps are grouped into three categories: (1) (white circles) identifying, defining, and analyzing the problem, (2) (light gray circles) seeking outside information, and (3) (dark gray circles) synthesizing ideas into new mental models.

A social constructivist framework helps us understand why we engage in case-writing according to this model and why we value particular aspects of the activity. This conceptual understanding also reveals our perspective on learning and allows us to model the process we hope our students follow during SGL. Awareness of the theoretical framework underpinning our own activity can inform curricular organization and ensure that case structure is consistent with the way in which we expect students to engage with cases.

Conclusions

This study examined the case-writing process within an integrated health sciences curriculum. For institutions moving toward integrated curricula, or for team-taught, interdisciplinary courses, it is likely that the model presented here will be valuable for those facing similar challenges. Our model for case-writing parallels the student learning process and facilitates the following:

- Anticipation of student challenges students during SGL
- Evaluation of problem authenticity
- Alignment of SGL with other curricular activities
- Ongoing review and modification

Recommendations for Case-Writing in an Interdisciplinary or Integrated Context

Based on our experience, we make the following recommendations for case-writing in an integrated curriculum:

- Case-writers should feel a sense of responsibility for the task.
- Facilitators and content experts should be included in the case review and modification to increase the sense of ownership and buy-in toward the case-based curriculum.
- Continual feedback and reflection is essential.
- Case-writers should be experienced facilitators and mirror the steps through which students progress in SGL.

- Case-writers must understand what an effective SGL session is like. Facilitator training may be one of the best ways to introduce case-writers to the structural requirements of good cases and to the benefits of collaborative group inquiry, which is new to many faculty members who are accustomed to working independently.

The Implications of Social Constructivism for the Case-Writing Process

In addition to describing our case-writing process, this study sought to place the activity within a theoretical framework that allows us to understand why aspects of the process are valued by case-writers and considered essential to the case-writing process. Viewing case-writing through the lens of social constructivism, we understand that the collaborative work and heterogeneity of experience within the group facilitates the construction of unique, interdisciplinary cases. We argue that social interaction at every stage of the case-writing process results in the construction of cases that encourage students to think in an integrated manner.

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Dr. Doubleday has a PhD in Biological Anthropology from Indiana University and a master's degree in Anatomy Education. At University of Illinois at Chicago, she teaches gross anatomy, embryology, and histology to first year dental students. Dr. Doubleday's research interests include the use of technology to mediate collaborative learning. Correspondence concerning this article should be addressed to Alison F. Doubleday, Department of Oral Medicine and Diagnostic Sciences, University of Illinois at Chicago, College of Dentistry, room 563D, MC 690, Chicago, IL, 60612; adouble@uic.edu.

Dr. Blase Brown is a clinical assistant professor in the Department of Oral medicine and Diagnostic Services at the University of Illinois at Chicago, College of Dentistry. He is the director of small group facilitation (SGL) in the DMD curriculum. In addition to his extensive involvement with curriculum development, Dr. Brown plans and gives training programs for SGL facilitators & students.

Dr. Patston has a PhD in Biochemistry from the University of Oxford. Before coming to UIC he was at Vanderbilt University. His research has covered metabolic enzyme regulation by phosphorylation, and the regulation of blood coagulation reactions by protease inhibitors. He has been very active in teaching and curriculum development in the College of Dentistry, with a focus on the integration of biochemistry and molecular biology with the other basic biomedical sciences.

Dr. Jurgens-Toepke has been a general dentist for over thirty years and a full-time faculty member for over ten years. She started her academic career at University of Illinois at Chicago, and is currently a Group Practice Coordinator at Midwestern University College of Dental Medicine-Illinois.

Dr. Strotman has worked at University of Illinois at Chicago, College of Dentistry since 2006 in both the preclinical and clinical settings. She is actively involved in curricular development.

Dr. Koerber is the director of behavioral science and the director of assessment at the University of Illinois at Chicago, College of Dentistry, where she coordinates the ethics and professionalism curriculum. Her research focuses on changing provider behavior.

Dr. Haley is a general dentist and Clinical Assistant Professor at the University of Illinois at Chicago, College of Dentistry, which he joined in 2012. Dr. Haley works primarily with development of the small-group learning curriculum.

Charlotte Briggs is Director of Teaching and Learning Support Services at Bay Path University, Longmeadow, MA, where she leads a Title III-funded initiative to redesign gateway courses and infuse mobile learning throughout the curriculum. Previously she served as Director, Center for Dental Education, at the University of Illinois at Chicago, after having taught higher education administration at Loyola University Chicago and the College of William and Mary.

Dr. Knight is Executive Associate Dean and Dean of Faculty at the University of Illinois at Chicago, College of Dentistry. His research interests focus on instructional design, delivery, and evaluation.

Sample Case Text: Includes Samples from Day 1 Case, Associated Learning Objectives, and Aligned Activities.

(Day 1 page 1)

Case 10 Reading Assignment (Read before Day 2): Histology & Cell Biology text: Chapter 5—Synovial Joints section (ebook pages 164–170).

Erin, age 45, presents to her dentist, Dr. Charles Spencer, because her mouth is dry and she wants a checkup. During the patient interview and history taking, Erin informs Dr. Spencer that her mouth has been feeling very dry for the past year. She often has to sip water in order to chew and swallow her food. She also needs to use a lot of ChapStick to keep her lips from cracking.

Dr. Spencer then asks Erin if she has been doing anything to keep her mouth moist. She tells Dr. Spencer about sucking on Life Savers during the day and keeping a water bottle bedside during the night. Erin also tells Dr. Spencer that lately she has been getting the feeling that something is in her eye.

(Day 1 page 2)

When asked by Dr. Spencer if she has seen a physician about her symptoms, Erin relates that it has been a few years since her last physical, and she is currently not taking any medications. Erin reports that she been very tired lately and has these other symptoms:

- Morning joint stiffness (hands, knees, ankles) that lasts for one to two hours
- Joint pain (hands, knees, ankles)

Dr. Spencer examines Erin's hands and fingers.

Facilitators: Ask students why a dentist would examine her hands.

(Day 1 page 3)

Extra-Oral Examination

- Slight enlargement of right parotid gland
- Dry/cracked appearance of vermilion border
- TMJ exam WNL

Students: Do not investigate temporomandibular disorders

Intra-Oral Examination

- Dry buccal mucosa
- Dry tongue
- Lack of pooled saliva in floor of the mouth
- Soft accretions of plaque & materia alba visible around cervical areas of most teeth
- Carious lesions detected on root surfaces of #: 14, 23, 25, & 26.
- Generalized gingivitis

(Day 1 page 4)

Dr. Spencer explains to Erin that she has a lot of plaque accumulating on her teeth. Erin tells him her hands are so stiff that brushing and flossing has become difficult. Also, her gums are more sensitive to the touch with the dryness.

Dr. Spencer then conducts a saliva flow test.

Unstimulated Whole Saliva	0.1ml/min
Stimulated Whole Saliva	0.5ml/min

Facilitators: See supplemental chart for range of unstimulated and stimulated whole saliva:

DAY 1 CASE OBJECTIVES

PATHOLOGY (DBCS)

1. Describe the criteria for the diagnosis of primary & secondary Sjogren's disease.
2. Describe the clinical manifestations of primary and secondary Sjogren's syndrome. Include the clinical signs of hyposalivation.
3. Describe the etiology, epidemiology, pathogenesis of Sjogren's syndrome.
4. Describe the relationship between hyposalivation, microbial overgrowth and increased risk for oral disease.
5. Describe the etiology, epidemiology, and pathogenesis of Rheumatoid Arthritis.
6. Describe the relationship of secondary Sjorgen's syndrome with associated connective tissue diseases.
7. Compare and contrast Type 1, Type 2, Type 3, and Type 4 immunological hypersensitivity reactions.
8. Compare and contrast Rheumatoid Arthritis and Osteoarthritis, including signs and symptoms.

CLINICAL DENTISTRY (DAOB*).*

9. Describe how to conduct and interpret the results of a saliva flow test: materials, clinical methods, flow values.
10. Describe the glandular contribution to stimulated and unstimulated whole saliva.

ANATOMY (DBCS)

11. Describe the general anatomic structure of synovial joints and contrast functional differences of specific synovial joints throughout the body. Relate these differences to range of movement present.
12. Describe the composition of synovial fluid and explain its synthesis within the synovial joint.
13. 20. Describe the histology of the salivary glands and ducts. Include a description of important cells in each gland.
14. Describe the physiology of mastication and swallowing, including control of masticatory movements, generation of occlusal forces, the role of sensory information from oral structures including lips, cheeks, hard palate, soft palate, teeth, periodontal ligament, and tongue. Include a description of the role of saliva.

The case provided is a facilitator's version. Case-writers develop a facilitator version of each case, complete with facilitator notes, answers to questions included in the case, and a list of objectives students are expected to encounter on each page of the case. A student version, lacking these details, is also prepared. As students work through this particular case, they participate in the activities listed above. When students encounter Day 1 of the case, there are relatively few curricular activities outside of SGL that provide students with an opportunity to interact with case content. By the time students have completed Day 3 of the case and learning objectives are released to the group, the students have had additional opportunities to build upon their knowledge in other contexts, such as through didactic or laboratory sessions. These sessions are led by clinical and biomedical science faculty.

	DAY 1	DAY 2	DAY 3
ASSOCIATED DIDACTIC SESSIONS	• Physiology of mastication	• Amalgam preparation and restoration	• Digestive system embryology (including salivary glands) • Inflammation • Hypersensitivities • Healthy periodontium • Professional communication
ASSOCIATED LABORATORIES		• Gross anatomy: Joint dissection (knee)	• Histology of upper digestive system & digestive glands • Gross anatomy: abdominal wall and viscera dissection