ORIGINAL ARTICLE

Understanding infection control professionals' educational practice: There is more to it than meets the eye

Gwyneth L. Meyers, PhD;[1] **Michele Jacobsen, PhD;**[2] **Elizabeth Henderson, PhD**[3]

[1] *Senior Clinical Practice Coordinator, Infection Prevention and Control, Alberta Health Services, Calgary, AB, Canada*
[2] *Professor and Vice Dean, Werklund School of Education, University of Calgary, Calgary, AB, Canada*
[3] *Professor Emeritus, Department of Community Health Sciences, University of Calgary, Calgary, AB, Canada*

Corresponding author:
Gwyneth L. Meyers
Infection Prevention and Control
Alberta Health Services
Room 3683A Peter Lougheed Centre
3500 26 Ave N.E., Calgary, AB T1Y 6J4, Canada
Tel.: 403-943-4157
gwyneth.meyers@ahs.ca

ABSTRACT

Background: There is a paucity of research exploring infection control professionals' (ICPs) educational practice and the daily challenges they face in providing education to change healthcare worker (HCW) behaviour and promote patient safety. Without closer examination of educational practice, ICPs cannot critically reflect on what, how, or why their educational approaches need to be improved or changed.

Methods: This research was conducted as part of a larger Design-Based Research study that looked at building ICP educational practice and culture within the Alberta Health Services (AHS) Infection Prevention and Control (IPAC) program. AHS ICP educational practice was explored using an online survey questionnaire, a focus group interview, and field observations of ICP educational practice. A qualitative systematic methodology was used to identify interconnected themes regarding ICP educational practice.

Results: Education is considered important and central to ICPs' professional practice. Despite its importance, ICPs are frustrated with the quality and effectiveness of the education they provide and seek ways to build their educational expertise. Four themes emerged in this study: the ICP's role as educator, circumstances influencing educational practice, educational strategies, and educational outcomes. These themes, along with their associated influences and challenges, illustrate the multifaceted nature of ICP educational practice in the AHS IPAC program.

Discussion: ICP educational practice is more complex than the IPAC educational research literature suggests. This study provides a detailed understanding of that practice and the multiple issues and processes involved in it. Making the complexity of ICP educational practice explicit validates ICPs in their role as educators and provides a foundation from which to build their educational expertise. Although ICPs are frustrated with the quality and outcomes of their education, their insights into their educational practice challenges indicate they are primed for change. ICPs seek innovative professional development experiences to change and build their educational expertise.

KEYWORDS

Infection prevention and control; education; teaching and learning; professional

INTRODUCTION

This paper is the third in a series of four discussing education in the field of infection prevention and control (IPAC). There is a paucity of research studying infection control professional (ICP) educational practice and the teaching and learning processes involved in providing effective education to facilitate healthcare workers' (HCW) behaviour change. Without an examination of that practice, we in the IPAC profession cannot critically reflect on what, how, or why our educational approaches need to be improved or changed.

IPAC educational intervention research focuses predominantly on formal information-giving strategies to improve HCW practice [1]. Such strategies do not necessarily prepare HCWs for translating knowledge into practice because the relationship between HCW knowledge acquisition and actual practice involves a complex interaction between knowledge, skills, and other social and cognitive psychological determinants [2-7].

Focusing predominantly on educational strategies for the purpose of knowledge-giving results in a constrained view of education that undervalues and overlooks the pedagogical concepts involved in teaching and learning processes to facilitate behaviour change [1].

Educational expertise is a core competency for ICPs [8-10]. However, professional development opportunities for ICPs to cultivate their pedagogical expertise are limited [11]. This gap is not unusual, as HCWs are often responsible for planning educational experiences without prior pedagogical training [12, 13]. It is well known that, without training, most teachers will teach as they were taught [14].

In response to these challenges, the educational practices of Alberta Health Services (AHS) ICPs were explored through an ecological teaching and learning process lens to inform the design of an ICP educational professional development experience [11]. To build ICP educational expertise and practice that moved beyond conventional educational strategies, it was first important to understand the nature of their educational practices. This study identified the complexity of ICP educational practice and the continual challenges ICPs face as they educate to change HCWs' behaviour. Several recommendations regarding ICP educational practice emerged from the study.

MATERIALS AND METHODS

The research and data collection methods reported in this paper took place within the context of a more complex Design-Based Research (DBR) study described in the second paper in this series [15]. The data analyzed in this paper were collected over six months (from mid-April to mid-October 2016) within the AHS IPAC program. An online survey questionnaire, a focus group interview, and field observations of ICP education sessions were used to collect data. Study participants for the survey were recruited via email from a convenience sample of all full-time ICPs employed by AHS. Participants for the focus group and field observations consisted of a smaller subset of ICPs who were recruited separately by email from the same convenience sample to participate in a Community of Learning educational professional development experience.

The survey included a mix of demographic, structured, and closed and open-ended questions. Modifications were made to the survey based on feedback from pilot testing. The focus group was conducted with a small group of ICPs who were participating in an educational professional development experience using a guide with open-ended questions. Focus group questions were designed to align with and build upon survey questions to gain a deeper understanding of ICP educational experiences, expertise, beliefs, attitudes, and educational practices. This alignment allowed for cross-checking of ideas and interpretations of findings that emerged from the survey.

Survey and focus group data, which are based on self-report, were subject to the risk of participants under- or over-reporting issues. To address this concern, field observations of the educational activities of the subset of ICPs who participated in the focus group were conducted. Observation is a means to study actual behaviour and concepts that have not been made explicit in self-reported data [16]. An observation tool was developed based on the concept of the learning ecology, taking into account the relationships amongst instructor, learners, content, teaching strategies, technologies used, and the educational environment [17, 18].

As data were collected, they were cleaned and entered into Microsoft Excel© and QSR Nvivo10© for analysis. Descriptive statistics were used to analyze some of the survey questions and a qualitative systematic methodology was used to code and analyze the remaining data, which focused on identifying emerging themes [19]. Three cycles of a systematic analysis by the researcher occurred for this part of the DBR study. The first cycle was a preliminary analysis of data as each research activity was completed. This preliminary analysis served to iteratively inform the design of next steps in the study. The second cycle analyzed all study data in the order in which it was collected after all data collection had been completed. This systematic approach provided an organized process for making sense of the data collected from different data sources. The third analysis cycle stemmed from the second and involved a re-examination and recoding of all data under the emerging thematic categories identified in the second cycle to identify further key themes within those categories. In this way, findings from different data sources were further synthesized and integrated under common themes or newly identified themes. This facilitated the movement from descriptive analysis to more analytic explanations of the data, expanding on and refining what was observed, as well as looking at relationships and process to theorize how or why things occurred.
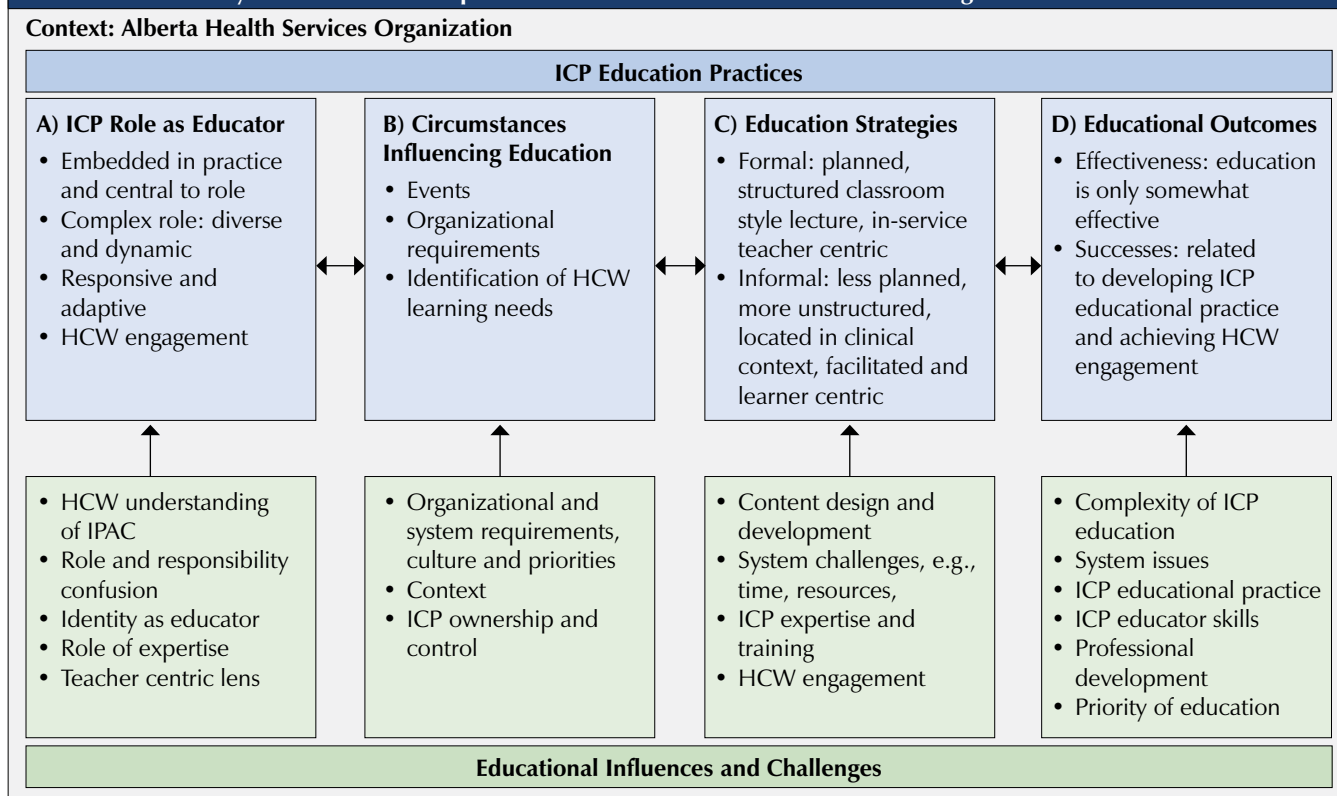
RESULTS

AHS IPAC is a province-wide program providing IPAC service across the continuum of care in both urban and rural healthcare settings. 48 ICPs participated in the online survey for a response rate of 55% (48/87) and eight ICPs participated in the focus group. Educational practice was observed for three of the eight ICPs in the focus group. Study participants in both the survey and focus groups were representative of the diversity of the program. ICP participants came from a variety of professional backgrounds, including microbiology, epidemiology, and nursing, and ranged in IPAC experience: 71% had less than five years' experience and 6% had over 15 years' experience.

Four main themes regarding ICP educational practice and associated influences and challenges emerged in the analysis: a) educator role, b) circumstances that influence ICP education, c) educational strategies, and d) educational outcomes. The attributes of each are summarized in Figure 1.

ICP educator role

Almost three quarters of the ICPs ranked themselves as having some educational expertise-based training that ranged from practice experience to a degree in Education. The most common type of training was obtained through conferences, workshops, and webinars. Independent of their IPAC experience, educational training, and perceived expertise, the majority of ICP respondents rated their role as educator as very important (85%, 41/48). Reasons for this importance are twofold. The first reason was

FIGURE 1: Summary of ICP educational practice and associated influences and challenges.

Context: Alberta Health Services Organization

ICP Education Practices

A) ICP Role as Educator
- Embedded in practice and central to role
- Complex role: diverse and dynamic
- Responsive and adaptive
- HCW engagement

B) Circumstances Influencing Education
- Events
- Organizational requirements
- Identification of HCW learning needs

C) Education Strategies
- Formal: planned, structured classroom style lecture, in-service teacher centric
- Informal: less planned, more unstructured, located in clinical context, facilitated and learner centric

D) Educational Outcomes
- Effectiveness: education is only somewhat effective
- Successes: related to developing ICP educational practice and achieving HCW engagement

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- HCW understanding of IPAC
- Role and responsibility confusion
- Identity as educator
- Role of expertise
- Teacher centric lens

- Organizational and system requirements, culture and priorities
- Context
- ICP ownership and control

- Content design and development
- System challenges, e.g., time, resources,
- ICP expertise and training
- HCW engagement

- Complexity of ICP education
- System issues
- ICP educational practice
- ICP educator skills
- Professional development
- Priority of education

Educational Influences and Challenges

ICPs' perception of education as "core," "central," and "critical" to their IPAC professional practice. ICPs viewed their role as "embedded in every aspect of that practice." The second reason was the purpose of the education, that is, "the transfer of knowledge" to front-line staff and other educators, in order to "facilitate change in practice."

The ICPs discussed their role as educators in terms of complexity. They indicated a need to be "responsive and adaptive" as educators because of the "diverse and dynamic" nature of the content of that education. Reasons reported for complexity included: a) the variety of HCWs' differing roles and professions, knowledge needs, and the fact that these HCWs were always changing, with new hires and role changes; b) the variety of contexts in which IPAC education occurred and the various reasons for that education; and c) the varied experience and approaches of the ICPs themselves, influencing their ideas about how to present IPAC information.

This complexity presented several challenges for ICPs as educators. The ICPs perceived that HCWs do not understand the breadth and complexity of IPAC practice, resulting in an underestimation of the scope of content and time needed for IPAC education. Compounding this lack of understanding is what one ICP described as "the motherhood and apple pie" issue. That is, everyone can agree that IPAC principles are important but practices such as hand hygiene are so ubiquitous and generalized that everyone thinks they know about it. Consequently, the concept of IPAC is well accepted but not well practiced: "Everyone knows it; they just don't do it." The ICPs also perceived that this misunderstanding results in a lack of HCW ownership

and taking responsibility for following IPAC practices. In the words of one ICP, "HCWs often want ICPs to solve their practice problems for them. I've said to a group before, 'You have to do your own infection control practice,' and then you look at me, 'You're not going to do it for me?' 'No, you have to wash your own hands.' It's really their job. We're just helping them figure out the background piece."

To address this complexity, the ICPs reported they invested time in what they described as "HCW engagement." This engagement required spending time to build collegial, collaborative relationships for the purposes of fostering credibility and trust through mutual learning and problem-solving; and to break down barriers of misunderstanding, mistrust, and negative perceptions of IPAC that could interfere with ICPs' teaching efforts. HCW engagement also meant "knowing your target audience," "knowing your learner IPAC needs," and "tailoring your education" using recognized principles of adult learning to make educational content relevant and meaningful. Although ICPs referred to the use of a variety of strategies, the pedagogical principles they apply are filtered through a conventional teacher-centric lens of information-giving as the knowledgeable expert (e.g., "I will assess and determine the type of presentation I will provide" and "What information I will give my audience?").

ICPs also struggled with their educator identity. The ICPs tended to view their educational role and subsequent practice challenges through the lens of an IPAC content expert, not through the pedagogical process lens of an educator. The ICPs reported that they did not feel prepared, supported, or confident in their educator role. This left them feeling uncertain about their

"credibility as an educator." Consequently, the ICPs struggled with feeling accepted as an IPAC expert within their educator role. Their reliance on conventional educational information-giving as a knowledgeable expert also resulted in a tension between being perceived as an expert authority and being authoritarian. The ICPs noted that conventional teacher-centric approaches have the potential to "disengage staff" if the teaching is perceived to be "dictatorial." One ICP pondered, "How does an instructor balance adult learning with not being patronizing?"

Circumstances influencing education

As educators, ICPs encounter a variety of circumstances that influence the development and delivery of education. When AHS and its IPAC program, with their respective educational cultures, responded to specific events, individual ICPs had varying degrees of control and ownership over the development of that education. The ICPs reported that it was difficult to both take ownership of and teach education prepared by others. It was easier if they were able to refine the content of the education to address local targeted HCW groups.

Administrative and legislative oversight organizations such as Accreditation Canada also influenced IPAC educational practice through mandated IPAC education and training for HCWs. To meet mandated education requirements and provide ongoing training for a large number of HCWs over a wide geographical area, the AHS IPAC program relied on the use of online education. The ICPs reported that the quality of online education was constrained by organizational system issues such as available technology, time and access to HCWs, the size of the organization, organizational branding, approval requirements, and a "one-size-fits-all" approach to education. ICPs perceived that online education favoured the provision of information over interaction and efficiency over effectiveness and they felt removed from such educational initiatives: "It doesn't even feel like yours anymore; it feels like somebody else's."

Sometimes educational circumstances were based on HCW knowledge or practice needs identified by clinical staff or by the ICPs themselves. These were recognized as the most common and rewarding educational opportunities whereby ICPs had more control over the content development and delivery of educational strategies. The ICPs indicated, however, that organizational and contextual issues tended to inform their choice of educational strategies.

Educational strategies

ICPs described the education they provided as both formal and informal. Formal education included planned, structured sessions that take place in classroom-type settings using a traditional lecture format. Within this formal education, the ICPs described using several teaching strategies, resources, and tools. Examples included using demonstration, case study, role play, and gamification. These strategies were often embedded within PowerPoint presentations to facilitate interactivity and HCW engagement. Adjunct reference materials such as information sheets and practice guides were often used to supplement content provided during the educational experience. While there was diversity and creativity in the activities

and resources used by the ICPs, the formal educational strategies, including interactivity, were predominantly teacher-centric, and the responsibility and focus remained primarily with the ICP to provide meaningful information. This is in contrast to a learner-centric approach, where the focus is on HCWs taking active responsibility for and directing their learning experiences.

Informal education was described by ICPs as "just-in-time teaching," "bed huddles," or "on-the-spot, in-the-moment" education, which usually occurred in the context of the HCW practice environment and was described as "embedded" and "implicit" in their educational practice. Although informal education could be a planned teaching experience, it was often considered less structured, more responsive and HCW-driven, and involving more collaborative learning, discussion, and problem-solving. The ICPs preferred informal approaches because these were perceived as more "usable," "applicable," and "relevant" for engaging HCWs in learning experiences that were "more effective in bridging the theory-to-practice gap." In informal contexts, ICPs described their educator role as "facilitator" rather than a "sage on stage."

When describing the development and delivery of education, most ICPs' approaches could be broadly categorized into phases of the ADDIE instructional design framework: analysis, design, development, implementation, and evaluation. Primary emphasis was on analysis and development with some attention given to evaluation. Evaluation was recognized as challenging and therefore not often done. In developing their educational approaches, some ICPs referred to educational principles of creating learning objectives and attending to concepts of adult learning or different learning styles. There was limited use of pedagogical language, or reference to pedagogical concepts more generally. Implementation received limited discussion apart from the challenges they encountered in delivering their education. Notably absent was attention given to instructional design, particularly in relation to designing for teaching and learning rather than designing for content delivery. In some cases, ICPs stated they "did not have an official approach" or "just did what seemed to work."

Two central themes emerged from ICPs' responses to challenges they had in developing their education: system issues and lack of educational expertise and training. System issues included: a) competing priorities from other aspects of their work, resulting in limited time to engage HCWs to assess their educational needs and to spend on developing education; b) limited resources such as technologies to develop education; c) increased focus on online education; and d) perceived lack of priority given to education both in the IPAC program and AHS as a whole.

The ICPs indicated that their limited educational training and lack of opportunities to build their educational expertise impacted their ability to design quality education. They cited their lack of "educational knowledge, skills, and experience" as making it "difficult to be creative" and come up with "advanced educational strategies." The ICPs were cognizant of their need for improvement to design more effective, impactful education but did not "know what changes to make" or "how to move forward" to make changes.

Challenges ICPs reported in delivering their education were similar to those identified in developing their education, with the addition of HCW disengagement. The competing priorities on HCWs' time, their workload, and other educational needs resulted in change fatigue, learning burnout, and cognitive overload; these were perceived to impact HCW motivation and attention to and retention of ICP education.

Educational outcomes

While the ICPs considered education to be important, 79% (39/48) saw the education they provided as only somewhat effective. Reasons reported for lack of effectiveness included: a) the complexity of ICP domain content and of teaching and learning processes as a whole; b) insufficient time and access to HCWs to provide effective education; c) ICP educational designs not effective in motivating HCWs to learn and engage with ICP content; d) the general quality of the education ICPs provided; and e) the need for additional development of ICP teaching skills.

Although the ICPs were frustrated with their educational efforts, they did describe some areas of success. These included improvements in their teaching approaches such as "improved use of PowerPoint" or "introducing a new teaching modality." The ICPs also considered they had achieved success when they sensed they had "bridged the theory-to-practice gap," when HCWs reflected an understanding of IPAC, its relevance to them, and how to apply it to their practice (e.g., "yeah, bringing it home" and "seeing those aha moments").

Each of the four educational practice themes described above (the educator role, circumstances influencing education, educational strategies, and educational outcomes) are reflexively interconnected, each influencing the other as part of a complex ecology of ICP educational practice. For example, the effectiveness of educational outcomes is not only influenced by the choice of educational strategies, but is also influenced by an ICP's confidence and experience as an educator, as well as the professional and organizational educational culture in which the education process occurs. The horizontal arrows between the four themes in Figure 1 are designed to illustrate these reflexive linkages.

Much of the current AHS ICP educational expertise is acquired through experience: "trial and error and self-learning," "borrowing materials from more experienced ICPs," and "watching them educate" – "You learn how it's done in IPAC." The ICPs indicated that they were "interested in learning different teaching strategies," "improving the quality of their education," and "building on their educational skills and expertise." To achieve this, several suggestions were made, including: a) the development of more teaching and learning professional development experiences; b) development of peer mentoring regarding educational practice; c) access to different teaching resources and strategies; d) opportunities to work with different teaching strategies to develop a deeper understanding of and comfort with those approaches; and e) raising the profile and priority of education in ICP educational practice.

Limitations

A limitation of this study is the unique nature of the AHS organization and the provincial nature of the IPAC program within AHS. As healthcare is a provincial responsibility, the organizational and cultural contexts that impact healthcare settings and the educational practices of IPAC programs may vary from province to province. While the findings in this study are both relevant and valuable to local AHS ICP educational practice, it is important to explore IPAC educational practices in other programs across Canada to scale up this current study's findings.

DISCUSSION

This study provides an in-depth understanding of AHS ICP educational practice, making explicit multiple issues and processes involved in that practice. ICP educational practice is more complex than the IPAC educational research literature suggests; the literature focuses primarily on the formal, conventional aspects of ICP education, treating education as an interventional tool rather than a complex ecology of teaching and learning processes [1]. Many IPAC educational intervention studies focus on the delivery of planned lectures and the development of online learning for the provision of knowledge, practice change, or increased access and uptake of information by healthcare providers [20-23]. In such studies, the discussion of the complex, dynamic nature of the ICP teaching and learning process, even of formal learning, is under-explored or missing [1]. The tacit nature of informal ICP education, descibed by ICPs in this study as more effective and rewarding, is generally not visible. Consequently, the relevance and importance of IPAC informal education goes largely unrecognized and therefore is undersupported and underresearched. Making explicit the multifaceted nature of their educational practice would validate ICPs' experiences and provide a foundation from which to build their practice.

The visibility of formal IPAC education reinforces the teacher-centric lens of information-giving by a knowledgeable expert. The emphasis on knowledge acquisition supports a teaching framework focused on designing for content delivery. This is different than designing for teaching and learning using strategies that attend to engagement, motivation, and desired learning outcomes, such as changed behaviour. Research has shown that teachers' beliefs about teaching and learning constrain their teaching practices and responses to those practices [24]. Even when teachers' pedagogies align with more active and engaged learner-centric approaches to teaching, they must still confront transforming educational practices amidst the constraining influences of the systems within which they teach. Unless they develop educational expertise, ICPs will remain hindered in their approaches to teaching and how they perceive and respond to educational challenges.

Further investigation of ICP informal teaching in the context of workplace learning is warranted [25]. The workplace is increasingly becoming a place of learning and research suggests that the majority of such learning is informal and situated in the context of social practice [26, 27]. This situatedness allows workers to connect their knowledge with practice and apply it in meaningful and relevant ways. Informal education described by ICPs is more social, collaborative, and situated in the HCWs' clinical practice and aligns

with more contemporary constructivist pedagogies [28]. It is not surprising that ICPs prefer their informal teaching approaches and describe them as more effective than their formal ones. In the contextual complexity of today's healthcare, ICPs need to shift from educating principally for HCWs' knowledge acquisition and skill development to designing learning experiences that facilitate HCWs' ability to adapt what they learn to new situations, generate new knowledge, and continually improve their performance [29]. Such education must focus on process and helping HCWs take responsibility for their own learning and engage in collaborative problem-based learning tasks and activities.

Given the ICPs' frustrations with their educational practice and insights into their educational challenges, it is clear that ICPs are primed for educational professional development experiences that encompass contemporary teaching and learning strategies. ICPs struggle with their lack of pedagogical knowledge as well as with their role and identity as educators. The ICPs are asking for help in designing more effective teaching and learning strategies. In response, these study findings were used to create an innovative professional development experience to build AHS ICP pedagogical expertise. This experience was designed to faciliate a conceptual shift from commonly held, traditional understandings and approaches to education to teaching strategies that align with constructivist theories of active and engaged learning. The assumption was that with increased pedagogical knowledge and experience and a language with which to collaboratively reflect on and discuss their practices and to explore their identity as ICP educators, the ICPs would be better able to respond to the complex teaching environment in which they find themselves and modify their practices for more effective learning and professionally satisfying outcomes. The design, development, and implementation of this professional development experience will be described in the fourth and last paper in this series exploring IPAC educational practice.

REFERENCES

1. Meyers, G., Jacobsen, M., & Henderson, E. (2018). An exploration of IPAC educational intervention research: What do we mean by education? *Canadian Journal of Infection Control, 33*(2), 89-95.
2. Nichols, A. B, & Badger, B. (2008). An investigation of the division between espoused and actual practice in infection control and of the knowledge sources that may underpin this division. *British Journal of Infection Control, 9*(4), 11-15. doi: 10.1177/1469044608088621
3. Cooper, T. (2007). Putting educational theory into clinical practice. *Journal of Hospital Infection, 65*(Suppl 2), 124-127. doi: 10.1016/S0195-6701(07)60028-0
4. Pessoa-Silva, C. L., Posfay-Barbe, K., Pfister, R., Touveneau, S., Perneger, T. V., & Pittet, D. (2005). Attitudes and preceptions toward hand hygiene among healthcare workers caring for critically ill neonates. *Infection Control and Hospital Epidemiology, 26*(3), 305-311.
5. Seto, W. H. (1995). Training the work force--models for effective education in infection control. *Journal of Hospital Infection, 30*(Suppl), 241-247.
6. Illeris, K. (2003). Workplace learning and learning theory. *Journal of Workplace Learning, 15*(4), 167-178. doi:10.1108/13665620310474615
7. Hager, P., & Smith, E. (2004). The inescapability of significant contextual learning in work performance. *London Review of Education, 2*(1), 33-46. doi: 10.1080/1474846042000177465
8. Burnett, E. (2011). Outcome competences for practitioners in infection prevention and control. *Journal of Infection Prevention, 12*(2), 67-90. doi: 10.1177/1757177410395797
9. Murphy, D. M., Hanchett, M., Olmsted, R. N., Farber, M. R., Lee, T. B., Haas, J. P., & Streed, S. A. (2012). Competency in infection prevention: A conceptual approach to guide current and future practice. *American Journal of Infection Control, 40*(4), 296-303. doi: 10.1016/j.ajic.2012.03.002
10. Moralejo, D., Catt, B., Ashcroft, M., Christou, H., DeFalco, K., Dyck, B., & Rhodenizer-Rose, S. (2016). *IPAC Canada core competencies for infection control professionals*. Retrieved from https://ipac-canada.org/photos/custom/Members/pdf/2016_IPAC_Canada_CoreCompetenciesforICPs.pdf
11. Meyers, G. L. (2017). Building educational practice and culture in infection prevention and control: A design-based research study. Retrieved from https://prism.ucalgary.ca/bitstream/handle/11023/3717/ucalgary_2017_meyers_gwyneth.pdf?sequence=1
12. Kern, D. E. (2009). Introduction. In D. E. Kern, P. A. Thomas, & M. T. Hughes (Eds.), *Curriculum development for medical education. A six-step approach* (2nd ed., 1-4). Baltimore, MD: John Hopkins University Press.
13. D'Eon, M. (2004). Point. . . counterpoint. An explicit critique of McLeod et al. 2004 on tacit knowledge. *Medical Teacher*, *26*(5), 487-489.
14. Bennett, C. (1991). The teacher as decision maker program: An alternative for career-change preservice teachers. *Journal of Teacher Education*, *42*(2), 119-130. doi: 10.1177/002248719104200205
15. Meyers, G. L., Jacobsen, M., & Henderson, E. (2018). Design-based Research: Introducing an innovative research methodology to infection prevention and control. *Canadian Journal of Infection Control, 33*(3), 158-164.
16. Creswell, J. W. (2012). Collecting qualitative data. In J. W. Creswell. *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (4th ed, 204-234). Boston, MA: Pearson Education.
17. Normak, P., Pata, K., & Kaipainen, M. (2012). An ecological approach to learning dynamics. *Educational Technology & Society, 15*(3), 262-274.
18. Cobb, P., Confrey, J., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9-13.
19. Creswell, J. W. (2012). Analyzing and interpreting qualitative data. In J. W. Creswell. *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (4th ed, 236-264). Boston, MA: Pearson Education.
20. Gould, D. J., & Chamberlain, A. (1997). The use of a ward-based educational teaching package to enhance nurses' compliance with infection control procedures. *Journal of Clinical Nursing, 6*(1), 55-67.
21. Atack, L., & Luke, R. (2008). Impact of an online course on infection control and prevention competencies. *Journal of Advanced Nursing, 63*(2), 175-180. doi: 10.1111/j.1365-2648.2008.04660.x
22. Bryce, E., Yassi, A., & Maultsaid, D. (2008). E-learning of infection control: It's contagious. *Canadian Journal of Infection Control, 23*(4), 228-237.
23. Koo, E., McNamara, S., Lansing, B., Olmsted, R. N., Rye, R. A., Fitzgerald, T., & Mody, L. (206). Making infection prevention education interactive can enhance knowledge and improve outcomes: Results from the Targeted Infection Prevention (TIP) Study. *American Journal of Infection Control, 44*(11), 1241-1246. doi: 10.1016/j.ajic.2016.03.016
24. Swan, M. (2007). The impact of task-based professional development on teachers' practices and beliefs: A design research study. *Journal of Mathematics Teacher Education, 10*(4-6), 217-237. doi: 10.1007/s10857-007-9038-8
25. Manuti, A., Pastore, S., Scardigno, A. F., Giancaspro, M. L., & Morciano, D. (2015). Formal and informal learning in the workplace: A research review. *International Journal of Training and Development, 19*(1), 1-17. doi: 10.1111/ijtd.12044
26. Eraut, M. (2004). Informal learning in the workplace. *Studies in Continuing Education, 26*(2), 247-273. doi: 10.1080/158037042000225245
27. Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participaiton*. New York, NY: Cambridge University Press.
28. Robinson, R., Molenda, M., & Rezabek, L. (2008). Facilitating learning. In A. Januszewski, & M. Molenda (Eds.), *Education technology: A defintition with commentary* (15-48). New York, NY: Routledge Taylor Francis.
29. Fraser, S. W., & Greenhalgh, T. (2001). Coping with complexity: Educating for capability. *British Medical Journal, 323*(7316), 799-803. 🍁