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## **Informed learning design: Teaching and learning through engagement with information**

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**Abstract:** While higher education teachers are able to use information in sophisticated ways to learn and communicate within their disciplines, they may not be accustomed to teaching their students to use information creatively and reflectively to support their work in a course. This paper introduces *informed learning design*, a curriculum design model by which teachers specifically enable students to learn course content through intentionally design engagement with information. Drawing from informed learning pedagogy and the variation theory of learning, the design model outlines an instructional pattern for enabling student awareness of critical aspects and features of the object being studied related to both information use and course content.

**Keywords:** informed learning, curriculum design, information literacy, higher education, pedagogy

## **Introduction**

Learning requires students to use information creatively and reflectively. A growing body of research shows that students use information with more sophistication when focused on particular aspects of disciplinary content (Andretta, 2012; Edwards, 2006; Limberg, 2000; Lupton, 2004, 2008). Building on these studies, a recent investigation portrays how learning outcomes may be enabled (or disabled) through the ways that students engage with information (Maybee, Bruce, Lupton, & Rebmann, 2017). To prepare higher education students to learn in an ever-changing information environment, it is essential that teachers intentionally design coursework that encourages students to become aware of how they use information as part of learning.

In this paper, we describe the outcome of an investigation to determine a process for designing higher education courses that enable students to learn course content through the intentional use of information. The result of our investigation is a curriculum design model,

*informed learning design*, that was conceptualized by drawing elements from two pedagogic frameworks: 1) informed learning (Bruce, 2008) and 2) the variation theory of learning (Marton, 2014; Marton & Tsui, 2004). The informed learning pedagogic framework emphasizes the role that engaging with information plays in learning. Elements of informed learning are positioned within components of a curriculum design model that includes defining learning expectations, and identifying assessment and learning activities. The model draws from variation theory to reframe elements of informed learning within each of the different design components by identifying critical aspects and features specifically related to learning course content through the intentional use of information. Those aspects and features guide the development and implementation of higher education courses.

## **Literature review**

### ***Informed learning***

Informed learning suggests that learning to use information is an integral part of learning about course content, such as disciplinary or professional knowledge and practices (Bruce, 2008). It re-conceptualizes information literacy from mastering a set of skills to experiencing using information to learn in increasingly complex ways. Informed learning builds on the findings from several phenomenographic studies revealing how educators (Bruce, 1997; Webber, Boon, & Johnston, 2005) and students (Andretta, 2012; Edwards, 2006; Limberg, 2000; Lupton, 2008a, 2008b) experience information literacy. These studies show that both educators and learners tend to experience using information with more sophistication when focused on learning about a disciplinary subject.

Grounded in a phenomenographic viewpoint, informed learning adopts a “relational” perspective in which using information is related to learning—more sophisticated ways of using information are associated with more complex learning of course content, and conversely more complex learning of content is related to more sophisticated information use (Bruce, 2008). While using information and learning course content may be thought of as two separate concepts, informed learning suggests that using information and learning are intertwined:

...information and information use could be regarded as mediators between learning intent and learning outcomes... Information use becomes one dimension of the complex phenomenon we know as learning. Being aware of the role of information and its uses becomes an avenue for improving learning.  
(Bruce, 2008 p. 15)

The three principles that guide informed learning propose that learning environments should:

1. build on learners’ previous experiences of using information to learn,
  2. emphasize learning to use information and disciplinary content simultaneously, and
  3. foster new awareness of both using information and disciplinary content
- (Hughes & Bruce, 2012b).

There are several characteristics associated with informed learning (Hughes & Bruce, 2012b). Like other contemporary approaches to teaching and learning, informed learning tends to employ active learning techniques, such as independent learning, problem-solving, and evidence-based practice. It has been investigated in high school (Smeaton, Maybee, Bruce, & Hughes,

2015), and undergraduate and graduate settings (Hughes, 2012; Hughes & Bruce, 2012a; Maybee et al., 2017). Informed learning typically involves students using information as they would in a real-life setting, including engaging in academic and professional information practices. For example, Hughes and Bruce (2012b) described an online cyber-learning course that focused on master's students learning to use information and content simultaneously. The students learned through simulated real-life activities involving the use of online tools as students learned about theories related to learning in online environments.

### ***Variation theory of learning***

The variation theory of learning is the key learning theory that emerged from insights drawn from previous decades of phenomenographic research (Marton & Pang, 1999). Whereas phenomenographers revealed how learners may be aware of different aspects of the same phenomena, variation theory suggests a pedagogic strategy for enabling awareness (Marton, 2014; Marton & Booth, 1997; Marton & Tsui, 2004). The focus of learning is referred to as an object of learning. Although typically used in reference to a lesson, an object of learning may also be used to refer to what students are expected to learn in a series of lessons, a course taking place across a semester, or an entire program of study. An object of learning involves an act, such as memorizing, interpreting, etc., which is directed towards content, such as formulas, concepts, history of a period, etc. Using information may be considered one kind of act through which people learn (Bruce, 2008; Lupton, 2008b).

To some degree, the object of learning is closely related to learning outcomes, learning objectives, learning goals or targets (Lo, Pong, & Chik, 2005; Pong & Morris, 2002). However, the object of learning is a broader concept that encompasses intentions for learning, how learning is enacted and how students experience it. As illustrated in Figure 1, an object of learning is

comprised of aspects or features of a phenomenon or situation (Marton & Tsui, 2004). To experience an object of learning “the learner must become aware of and take certain aspects of the object of learning into consideration simultaneously. Those aspects that a learner has to notice, but is not yet able to, are critical aspects for that person’s learning. The learner must learn to discern the critical aspects of the object of learning and some critical features simultaneously and, by doing this, enhance the likelihood of being able to discern the same or other critical features of novel tasks” (Marton, 2014, p. 26).

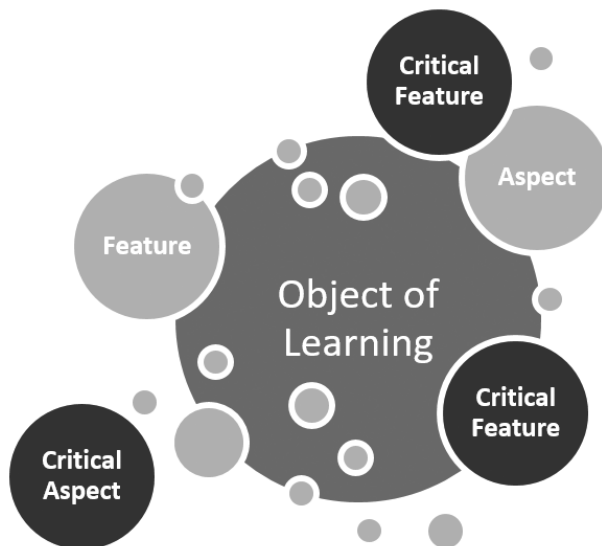


Figure 1: Aspects and features associated with an object of learning

The critical aspects of an object of learning, as argued by Pang and Ki (2016), are relational in nature, in the sense that they are related to the learners’ qualitatively different ways of seeing the phenomenon or situation (e.g. learners’ alternative ways of seeing it versus the perspective of a given discipline). For example, regarding the phenomenon of market price, quite a number of learners see price as a function of the properties of the commodity itself (such as size, taste, and etc.), whereas others regard it as a function of market conditions (i.e. market

demand and supply), which is the desirable way of seeing it from the disciplinary perspective of economics. The latter could be further categorized in a more sophisticated way, based on whether the learner views it as a function of either market demand or supply or as a function of both simultaneously. Correspondingly, the critical aspects of the object of learning, which is to enable learners to see market price from the perspective of economics, refers not only to the dimensions of market demand and supply, but also to the properties of the commodity. To bring learning about, the teacher needs to vary the critical aspects and features of the object of learning consciously and systematically so that learners can discern and focus upon them (Marton, 2014; Marton & Tsui, 2004).

Whether for a lesson or an entire course, specific variations, referred to as the *pattern of variation*, must be not only present, but experienced by students to enable learning (Marton & Trigwell, 2000). While earlier works recognized four kinds of variations, Marton (2014, p. 86) suggests that there are two overarching ones: *separation* and *fusion*. Separation is when select aspects or features of an object of learning are experienced as varying while others are held “invariant,” meaning they are not varied. There are two kinds of separation: *contrast* and *generalization*. Contrast occurs when an aspect or feature is compared with something else. Generalization occurs when instances of an aspect or feature are experienced all at once. These instances may have been experienced in the past or be something that a student may not have encountered before. For example, a critical aspect of scholarly journal articles may be the “genre” of “journal.” Students might be asked to compare different features of genre, such as a blog, news, television shows, and so forth. Other aspects, such as content, or topic, would be held invariant. After comparing types of genre, students could then be asked to simultaneously connect previous encounters with journals to other instances when they encountered the genre of



journal, such as popular magazines, personal journals, and so forth. Fusion is a type of variation that happens when critical aspects and features are focused on simultaneously.

There is a small body of research that has used variation theory to examine informed learning (Maybee et al., 2017; Smeaton et al., 2015). One study examined a teacher and students' experiences of using information to learn in a language and gender undergraduate course (Maybee et al., 2017). In this paper, we illustrate the components of informed learning design through drawing on this course, and we juxtapose it with a hypothetical environmental engineering course.

### *Curriculum design*

Curriculum or instructional design developed with the intention of making educational programs more effective and efficient. Providing a structured approach, curriculum design may also support the development of curricula grounded in theoretical insights about teaching and learning. For example, the ADDIE model (Branson et al., 1975) is comprised of five components: 1) analysis of learning needs and goals, 2) design of an instructional strategy, 3) development of lesson plans and materials, 4) implementation, and 5) evaluation of the effectiveness of the instruction. The ADDIE model considers elements of the learning environment, such as identifying learner characteristics, delivery options, and constraints imposed by the environment on the intended learning.

The Dick and Carey model (Dick, Carey, & Carey, 2009) offers a similar list of components to ADDIE. The components of the Dick and Carey model include: 1) develop instructional goals, 2) conduct an analysis, 3) determine learner characteristics, 4) define performance objectives, 5) create test items, 6) outline learning activities, 7) create instructional

materials, 8) determine assessment strategy for improving learning, and 9) determine assessment strategy for evaluating learning at the end of the learning experience. However, the Dick and Carey model emphasizes a systems view, suggesting that the various elements are to be understood holistically.

Another popular curriculum design model used in higher education is backward design (Wiggins & McTighe, 2005). This model is comprised of three components: 1) identifying learning outcomes, 2) developing an assessment plan, and 3) selecting learning activities. Although there are only three components, each encompasses many of the specific activities included in the other models. However, backward design differs from other models in that it is underpinned by social constructivist learning theory (Vygotsky & Cole, 1978). Thus, the components emphasize the creation of learning environments intended to foster learning as defined by social constructivism.

While structured in different ways, all of the curriculum design models examined have components focused on:

- 1) identifying goals of learning,
- 2) developing learning activities, and
- 3) evaluating learning gains.

Drawing from these models, *informed learning design*, the model introduced in this paper, has components intended to address each of these three components of curriculum design. The variation theory of learning (Marton, 2014; Marton & Tsui, 2004) guides pedagogic choices within the different components of the informed learning design process.

## Methodology

The aim of this paper is to propose a curriculum design approach that higher education teachers can use to enable students to intentionally use information in more sophisticated ways to learn disciplinary content. The research questions guiding this work are:

- What is a process for designing higher education courses that enable students to learn course content through the intentional use of information?
- What elements need to be considered within that process?

Although it grew out of the same phenomenographic research tradition as the variation theory of learning, only recently have researchers explored the relationship between informed learning and variation theory's insights concerning the need for learners to become aware of critical aspects and features of an object of learning (Maybee et al., 2017). Both relational in nature, informed learning may leverage variation theory to offer a pedagogic strategy to teachers who desire to have their students become aware of aspects and features related to using information as they learn about course content. With the exception of some cases describing a specific disciplinary context (ex: Hughes & Bruce, 2012a, 2012b), the scholarly literature does not describe specific elements of informed learning course curriculum, such as expectations for learning, assessment, and learning activities for university level courses, nor does it offer approaches to creating such elements. To answer the research questions, the project described in this paper analyzes the relationship between two frameworks: informed learning (Bruce, 2008), and the variation theory of learning (Marton, 2014; Marton & Tsui, 2004). Elements from each framework are drawn together to conceptualize a new design model, informed learning design,

which enables the creation of higher education courses that make it possible for students to learn course content while explicitly and simultaneously focused on using information.

The first step of the project involved identifying how the principles and other elements of informed learning can be associated with discrete components typically used to guide the creation and implementation of higher education course curricula. The components include defining expectations for learning, identifying learning activities and assessment. The second step of the project focused on determining how key elements of variation theory can be used to refine the articulation of informed learning. This involved identifying critical aspects and features and determining the pattern for varying them that may enable learners' awareness of them. Such aspects or features may be associated with using information or course content (Bruce, 2008; Lupton, 2008b). Three design components that comprised informed learning design were subsequently developed. These are described in detail in the following section.

### **Informed learning design**

Drawing from informed learning (Bruce, 2008) and the variation theory of learning (Marton, 2014; Marton & Tsui, 2004), informed learning design encompasses three components (see Fig. 2):

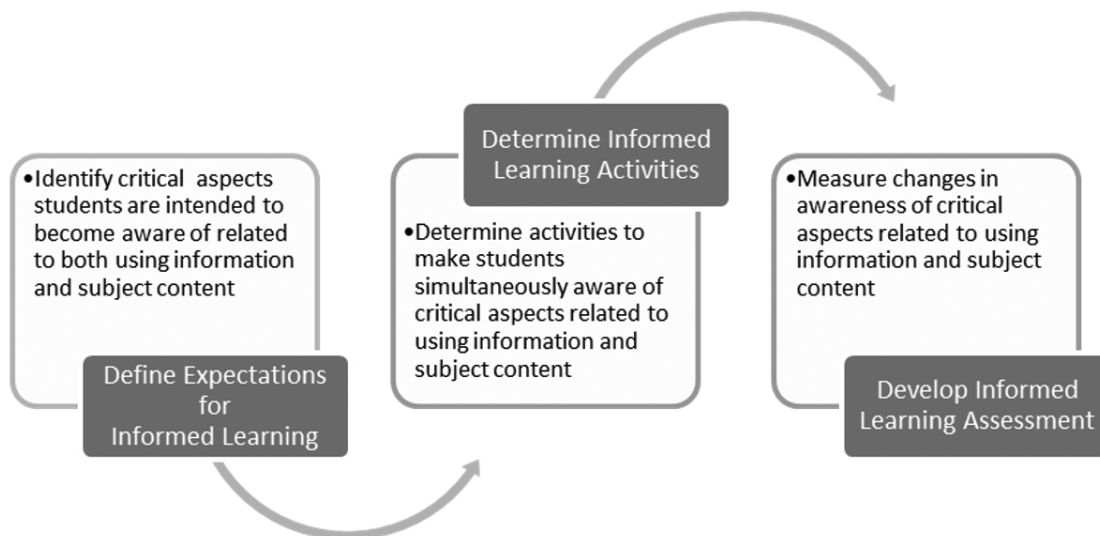


Figure 2: Components of Informed Learning Design

Described in Table 1, each of the three principles of informed learning: 1) build on learners’ previous experiences of using information to learn, 2) emphasize learning to use information and disciplinary content simultaneously, and 3) foster new awareness of both using information and disciplinary content (Hughes & Bruce, 2012b) are reflected in each component of the informed learning design process.

Table 1: Relationship of informed learning principles and informed learning design components

	Components		
Principles	Define expectations for learning that...	Determine learning activities that...	Develop assessment that...

Build on learners' previous experiences of using information to learn	Account for learner's prior experiences	Build on learners' prior experiences	Reflects learners' changes in awareness in relationship to prior experiences
Emphasize learning to use information and disciplinary content simultaneously	Enable learning through specific ways of using information	Enable awareness of content through specific ways of using information	Reveals increasing awareness of learning that results from using information
Foster new awareness of both using information and disciplinary content	Include both information use and content	Enable awareness of both information use and content	Reveals increasing awareness of information use and content

During the first component of informed learning design, the teacher defines the learning they expect of students, which reflects the content the students need to know, but also how they are to become aware of using information. Illustrated in Figure 2, the teacher identifies aspects or features related to the content and to using information that are critical for students to become aware of to learn as intended. In determining learning goals, the teacher must consider students' previous experiences of the content as well as their experiences of using information to learn the content. The teachers' intentions for learning, typically reflected in learning goals or outcomes, should encompass how the students are expected to become aware of using information and disciplinary content. Thus, in an informed learning environment (Bruce, 2008), these intentions should focus on how using information and disciplinary content come together as a single learning goal that emphasizes a simultaneous focus on these concepts.

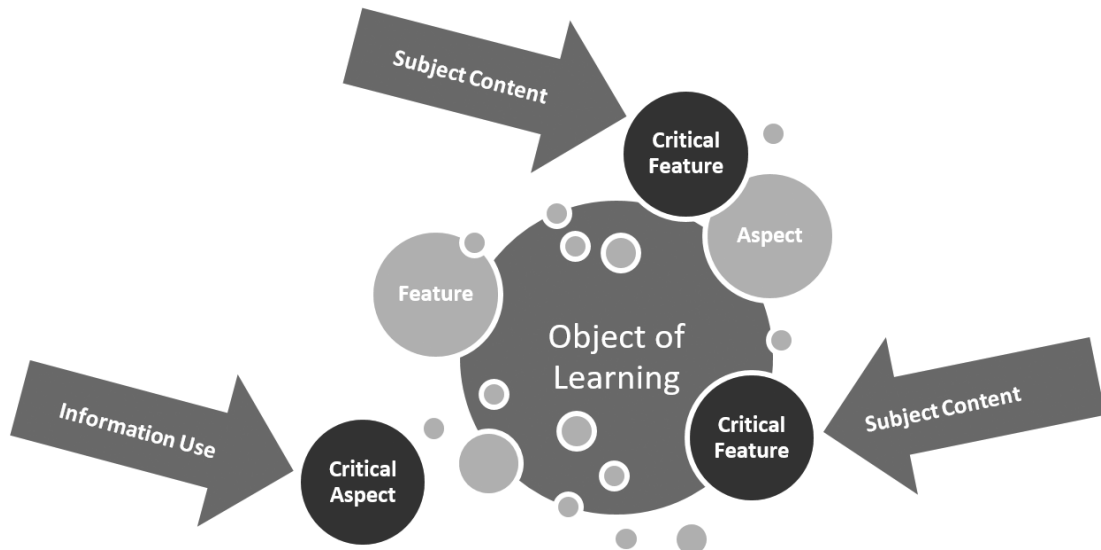


Figure 3: Aspects and features associated with an object of informed learning

The second component focuses on the teacher identifying learning activities, such as class discussion, lectures, group work, and so forth, which encourage learners to become aware of the critical aspects and features that support a new understanding of the subject through engagement with information. Accounting for students' prior experiences, the third component focuses on assessment that reflects students' increasing awareness of simultaneously using information and learning disciplinary content. In the next section, we outline the components in more detail.

### *Define expectations for informed learning*

The informed learning design process begins with determining what students are meant to learn from the course. Drawing from variation theory (Marton, 2014; Marton & Tsui, 2004), informed learning design defines learning as a greater or more complex awareness of the phenomenon being studied in the course. In practical terms, this means defining objects of

learning for the course, which encompass both the content and the process of learning (Kullberg, Mårtensson, & Runesson, 2016).

Defining an object of learning for informed learning involves:

- identifying aspects and features related to the object of learning,
- determining which aspects and features relate to using information and which relate to content, and
- deciding which aspects and features are critical for learners to become simultaneously aware of to allow them to learn as intended.

An object of learning does not require that students experience all aspects and features of a phenomenon, but instead focuses on those that are critical for understanding the phenomenon in the way intended by the teacher. Determining which aspects are critical for informed learning requires that teachers have some knowledge of learners' awareness of the phenomenon prior to teaching (Hughes & Bruce, 2012b). Therefore, to the extent possible, students' capabilities should be identified via diagnostic tools at the start of the course (Lo, Marton, Pang, & Pong, 2004). Experienced teachers may also have this knowledge from past experience of teaching the course.

### *Example 1*

The first example is from an upper-level language and gender course where the teacher intended for her students to have the experience of understanding a topic by tracing its trajectory through research (Maybee et al., 2017). The teacher had taught the course for many years and knew that students typically had difficulty grasping how an essay analyzing the research trajectory of a topic differed from a typical academic essay they were asked to write in other



courses. Several critical aspects and features were associated with the object of learning, such as a *sequence of research*, referring to the analysis identifying how a topic evolved over time, and a *seminal text* presenting a highly original idea that influences the development of future research. The feature of *sequence of research* was associated with using information, while the other aspects, such as the specific *topic* each student planned to investigate, were associated with course content. The aspects and features that were critical for the students to become simultaneously aware of to experience the object of learning as the teacher desired were *sequence of research*, *topic*, and *claim*, which came together to enable the students to understand the topic as evolving and continuing to evolve.

### *Example 2*

The second example is from a hypothetical environmental engineering course where students undertake an engineering design solution to address an urban environmental problem determined through an analysis of demographic data. As with the first example, several aspects and features may be associated with the object of learning. A feature associated with using information is *data-driven problem conceptualization*, referring to the recognition of an environmental issue and its cause through the analysis of relevant data. Aspects associated with course content include the *cause* of an *environmental issue*, *design model characteristics*, *engineering solution*, and an *environmental issue*, such as water pollution, climate change, or deforestation. The aspects and features that are critical for the students to become simultaneously aware of to experience the object of learning as the teacher intends are *engineering solution*, *data-driven problem conceptualization*, *environmental issue*, and *cause*. They come together to enable the students to identify a solution that would counter or disrupt the cause of a specific environmental issue determined through analysis of urban data.

### *Determine informed learning activities*

Informed learning activities are intended to help students become aware of using information and content simultaneously. Drawing from variation theory (Marton, 2014; Marton & Tsui, 2004), informed learning design guides this process by focusing on the development of activities to enable the students to become aware of critical aspects and features associated with using information and content. The specific learning activities may vary widely, depending on the content of the course and the information practices the teacher has identified as relevant. Drawing on the concept of ‘assessment for learning’ (Boud & Associates, 2010), learning activities may also be assessment. For example, the essay completed by the students in the language and gender course would allow the teacher to assess student awareness of critical aspects and features, yet through completing the assignment also enable students to become aware of those aspects and features.

Across a series of interactions, such as assignments or lessons, the variations that are made related to an object of learning form a pattern of variation. The idea that learning is enabled through exposure to a pattern of variation is the main premise of variation theory (Marton, 2014; Marton & Tsui, 2004). Variations can occur through direct actions by the teacher, such as lecturing, and through participation in activities that the teacher arranges, such as group discussion or projects. As outlined in Figure 4, a pattern of variation that enables students to experience informed learning will involve separating and then fusing critical aspects and features related to both using information and content.

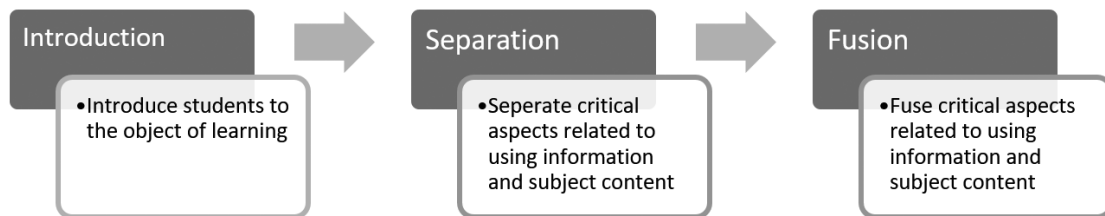


Figure 4: Pattern of variation necessary for informed learning

*Example 1*

The language and gender course we are using as an example illustrates a pattern of variation for informed learning (Maybee et al., 2017). The teacher of this course introduced an essay assignment during a class session in which she separated critical aspects and features related to understanding a topic by tracing its trajectory through research. After having the students brainstorm potential topics, the teacher fused the aspect of *topic* and the feature of *sequence of research* by providing her own example describing how the topic of gender and conversational interruption evolved through research. The students were asked to select a seminal topic, and outside of class time, search for scholarly articles on the topic and determine how the research described related to the seminal work. In a later session, the teacher arranged the students in small groups to critique each other's draft thesis statements to determine if each statement reflected a claim about the topic based on an analysis of how the topic evolved through research. The variations that occurred throughout the second lesson were primarily forms of fusion in which the feature of *sequence of research*, which is associated with using information

and the aspects of *topic* and *claim*, which are associated with course content, were focused on simultaneously.

### *Example 2*

In the example of the hypothetical environmental engineering course, the teacher introduces a project in which the students are to create a design that addresses an urban environmental issue. Similarly to the language and gender course (Maybee et al., 2017), the teacher in the environmental engineering course introduces the assignment in a lesson that separates the critical aspects and features related to determining a solution (*engineering solution*) that addresses the *cause* of an urban *environmental issue* by analyzing demographic data (*data-driven problem conceptualization*). Fusing the critical aspects and features, the teacher provides an example of an engineering solution that is responsive to an environmental issue understood through an analysis of urban data, and compares it to a design solution that is not grounded in a data-driven understanding of the environmental issue. In a later class session, students are introduced to urban data sources and analysis techniques to enable them to conceptualize an environmental problem. Students individually create proposals that describe an engineering solution that is responsive to an environmental issue understood through the analysis of urban data and post them online. Each student then comments on two other students' proposals. Peer reviewers follow guidelines that allow their feedback to create the variation of fusion by focusing on whether a proposal reflects a simultaneous awareness of an *engineering solution* that addresses the *cause* of an urban *environmental issue* understood through data analysis (*data-driven problem conceptualization*).

### ***Develop an assessment plan for informed learning***

The key question to drive assessment of informed learning is, *Are the students aware of the content in ways that reflect using information intentionally?* Thus, an assessment plan for informed learning involves formative and summative assessment of student awareness of aspects and features related specifically to using information and course content. Formative assessment focuses on gauging students' awareness of critical aspects and features, as well as how they are being experienced simultaneously. This type of assessment allows teachers to adapt their teaching to focus students' awareness to critical aspects and features outside of the students' experience. Summative assessment formally determines if students are simultaneously aware of the critical aspects and features.

Assessing student awareness may be difficult for teachers whose experiences of assessment have focused on quantitatively measuring what students know about a subject. A typical concern is that the type of assessment for which informed learning design advocates will be time consuming to complete, particularly in courses with large numbers of students. Nevertheless, as pointed out by Biggs (1996), teaching that aims to have students create new meanings, rather than focusing on memorization or reproduction, requires assessment that can measure such growth. Strategies for managing this type of assessment include using or developing scales that allow for the standardization of feedback focused on students' awareness of critical aspects. If necessary, the quantitative data produced from these types of tools can satisfy programmatic or institutional needs for numeric assessment (Micari, Light, Calkins, & Streitwieser, 2007). It is also possible to envision using tests to determine students' awareness of an object of learning (Newton & Martin, 2013). For instance, teachers could draw from research findings that describe different ways the concept they are teaching may be experienced, and they

could use this knowledge to craft assessment questions that reveal critical aspects or features of the concept (Åkerlind, McKenzie, & Lupton, 2011; Forster, 2017).

However, due to the nature of informed learning, holistic projects in which students are engaged in using information to learn are more likely to provide opportunities to determine student awareness related to using information and course content. These assignments are similar to the student work typically required in higher education courses; however, they are different in that they would reveal students' awareness of critical aspects and features. Where appropriate to a field of study, these assignments would be authentic real-world tasks or simulations of real-world tasks.

In addition to allowing learners to become more aware of their own information-related experiences (Hughes, Bruce, & Edwards, 2007), reflective exercises, such as journaling, online discussion, and so forth, may serve to provide a teacher with insights into students' shifting awareness. For instance, the teacher in the example study of the language and gender course used research logs in which the students described how they gathered the materials they used to analyze a topic (Maybee et al., 2017). Reflective assignments should be guided by the object of learning; this is to say, students should be asked to reflect on their shifting awareness of the aspects and features that are part of learning through engagement with information.

### *Example 1*

In the language and gender course, the summative assignment was an essay modelled after scholarly essays drawn from the field of linguistics (Maybee et al., 2017). The student's thesis statement needed to communicate an awareness of how the *topic* of the essay evolved through research (*sequence of research*), as well as making a *claim* about the future direction of

that research. Leading up to the finished essay, students completed formative assessment such as a written topic statement and an annotated bibliography, which provided the teacher with insights into the student's awareness of the critical aspects and features of the object of learning.

### *Example 2*

In the hypothetical environmental engineering course, the summative assessment is an engineering design (*engineering solution*) that reflects a simultaneous awareness of the *cause* of an urban *environmental issue* determined through data analysis (*data-driven problem conceptualization*). Formative assessment includes brief written descriptions of the data analysis resulting in the determination of an environmental issue and its cause, and a proposal outlining multiple engineering solutions comparing responsiveness to the issue as understood through the analyzed urban data.

## **Discussion**

Informed learning design guides the creation of course curricula that fosters students' ability to learn through engagement with information. The design model allows higher education teachers to intentionally create learning environments that simultaneously enable students to learn course content while becoming aware of new ways of using information. Enabling students to use information in holistic and authentic learning contexts is essential for preparing them for success after university (Head, 2012).

Informed learning design is also a way of developing a scholarship of teaching (Boyer, 1990). Variation theory can be used as a type of pedagogical content knowledge (Shulman, 1986) where the identification of critical aspects and features that learners need to become aware

of through the course guides the design of teaching, learning activities and assessment.

Following the design model, coursework can be created that fostered a pattern of variation in which aspects and features related to using information and content are varied across a course to enable students to learn as intended. Typically, teachers would use their own experience to identify the aspects and features students need to become aware of based on their knowledge of how students tend to learn in the course (Åkerlind, McKenzie, & Lupton, 2014).

Teachers can also adopt a higher level of scholarship in the design and implementation of informed learning. There is precedent for this kind of research in an approach referred to as “learning study” (Pang & Marton, 2003). Learning studies are similar to “lesson studies,” which is a model for improving lessons that is used in Japan in which select lessons are collaboratively planned and observed by a group of teachers, as well as video-recorded, and then discussed (Lewis, 2000). Learning study uses the same set of procedures, except the variation theory of learning is used to define the object of learning (Pang & Marton, 2017).

Learning studies typically involve a collaborative effort between researchers and classroom teachers (Marton & Pang, 2006). Teachers are exposed to key ideas from variation theory (Marton, 2014; Marton & Tsui, 2004), and use their prior experiences of teaching and learning to design lessons that enable the variations necessary for the intended learning to occur (Pang, Linder, & Fraser, 2006). A version of this approach was used as an action research project with researchers and teachers in law and physics (Åkerlind et al., 2014). The researchers and teachers met to decide on the critical aspects and features of a threshold concept in law (legal reasoning) and physics (uncertainty). A phenomenographic study was conducted into students’ understandings of these concepts, and learning activities were designed to develop students’ awareness of critical aspects and features.



Learning study has not yet been used to study informed learning. To create such a study, teachers would reflect on and determine which aspects and features are critical to an object of learning that focuses on using information to learn. If they were working with a researcher, the researcher and the teachers would observe in-class enactments of lessons and determine the pattern of variation used by the teachers. They would then interview students or examine student work to determine if the students are aware of using information to learn in the way the teachers had agreed on prior to delivering the lessons. Using variation theory as a guide, the researcher and teachers determine if the students are learning as intended, and modify the lessons taught during the next iteration of the course until students' awareness aligns with the teacher's intentions for learning.

### **Future directions**

Informed learning design offers a framework for intentionally developing coursework in which students learn about and practice using information as they learn disciplinary content. Elements of informed learning design have been used to guide collaborative work between teachers and instructional developers (Maybee, 2018). Informed learning design needs to be applied in the creation of new university courses—the outcome of which should be examined using the learning study methodology. Such efforts will further inform the design model with the goal of increasing its use at higher education institutions. To be successful in future professional or academic work, higher education students must develop sophisticated ways of using information in various learning contexts. Recognizing the struggles students may face (Head & Eisenberg, 2010), informed learning design provides practical guidance for teachers to create learning environments that enable their students to learn to use information in disciplinary courses.

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