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Teaching Evolution: The Blog as a Liminal Space

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Abstract

A *threshold concept* is a challenging concept that acts as a doorway leading to deeper understanding and a dramatic shift in perception. A learner that is involved in grasping a threshold concept is said to be undergoing a threshold experience within a *liminal space* or learning environment. We used the blog as a liminal space for our students to engage with the theory of evolution, which is a threshold concept. In order to teach evolution effectively it is necessary to address both understanding and acceptance of evolutionary theory. To explore the latter in an introductory biology course, we used a series of reflection assignments, submitted by students using a blog format, designed to inform, engage, and probe students' views on evolution without dismissing their prior beliefs. Using the blog feature on our learning management system (LMS), students were asked to feel free to express their views on the nature of science (NOS), evidence for evolution and natural selection, and the application of the concept of non-overlapping magisteria (NOMA) to the evolution-versus-creationism debate without fear of being graded poorly for a wrong response. Grades were based solely on the level of engagement expressed via thoughtful responses to the specific prompts within each reflection assignment. A student reflection rubric was used to grade and assess student performance and allowed us to examine how students integrated evolution into their prior knowledge. We found the blog to be a highly effective online tool to closely analyze students' written reflections on a topic that can be both intellectually and emotionally challenging.

Keywords: Threshold concept, liminal space, evolution, student reflection, rubric, blog, NOMA, NOS.

Threshold concepts

A *threshold concept* is one which, when grasped by the learner, can result in a completely new way of thinking. It is described as a doorway that leads to a deeper understanding of a concept and a significant shift in perception (Meyer & Land, 2003). While the identification of particular threshold concepts in the various disciplines and sub-disciplines is a continuing process, producing much discussion and disagreement (for example, see Ross, Taylor, Hughes, Whitaker, et al., (2010) or Rountree & Rountree, (2009)) the general

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characteristics of these concepts are well established. Threshold concepts are, by their nature, both *transformational*, meaning they produce a profound shift in the learner's thinking, and *troublesome*, or conceptually difficult, alien, tacit, or counterintuitive. Confronting a troublesome concept can produce a phenomenon in which the learner remains "defended" and does not wish to let go of familiar ways of thinking (Meyer, Land, & Baillie, 2010).

The crossing of this threshold is characterized by a *threshold experience*, in which the learner must navigate the conceptual landscape (Land et al, 2005). In order to do this, the learner must first be willing to enter a *liminal space* in which the threshold experience happens. Within this liminal space, the learner approaches the concept and engages with it fully. The threshold experience itself is not unlike an adolescent state where the learner oscillates between child-like ways of thinking and newer, adult ways of thinking punctuated by feelings of frustration, moments of clarity, and confusion. This learning process therefore is rarely linear, but involves venturing out or taking bold *excursions* into unfamiliar waters of the new concept and retreating or taking *recursions* back into areas of confusion or previously held notions, before the concept is grasped fully. (Land et al, 2005). Students who refuse to enter the liminal space and engage in the struggles associated with the threshold experience are said to exist in a *pre-liminal state* where their understanding of the concept remains vague at best.

Struggling to master a concept is part of the threshold experience and in this paradigm of learning the role of the instructor, among other things, is to create a *supportive liminal environment*, encouraging them to engage in the messy process of trying to grasp the threshold concept (Land et al, 2005; Cousin, 2006). While the liminal space is a conceptual construct, meant to evoke an arena where students can move back and forth, toward and farther away from a robust understanding of the concept, recent research has demonstrated the usefulness of online tools as an actual liminal space (Gerofsky, 2015; Tate, Gillum, & Mandalas, 2014; Wood, 2012). These tools, such as the use of student blogs, have become important parts of many teaching strategies (Oravec, 2003) and have attributes that make them perfectly suited for the threshold experience. Owen, Grant, Sayers, & Facer (2006) describe "social software" (including blogs) as allowing students to feel "supported to take risks and develop understanding in unfamiliar knowledge domains." Wood (2012) found that the blog-as-liminal-space was successful in encouraging learners to engage with threshold concepts in a personalized way.

Evolution as a Threshold Concept

The majority of students entering college have little exposure to evolutionary theory with most having only a vague idea of its importance in biology (Alters & Nelson, 2002; Moore, Cotner, & Bates, 2009). In a previous article we described how we present the theory of evolution to students in an introductory biology course, using highly relevant examples such as antibiotic drug resistance, lactose tolerance, evolution of skin color, and the evolutionary tradeoff between sickle cell anemia and malaria (Wolf. & Akkaraju, 2014). While this approach continues to work for us in promoting understanding of evolutionary theory it still does not address the students' acceptance of evolution or how they

integrate evolution with their personal beliefs to achieve some degree of cognitive equilibrium (Dagher & BouJaoude, 1997). While seemingly connected, it has been shown that there appears to be no relationship between student understanding and acceptance of evolution (Sinatra, Southerland, McConaughy, & Demastes, 2003) and therefore each aspect needs to be addressed differently.

Evolutionary theory, and the concepts embedded in it, has been identified as threshold concepts (Taylor, 2006), meaning that they are both troublesome and transformational (Meyer & Land, 2003). Threshold concepts have been described as troublesome because they can appear illogical or conflict with some previously held belief or understanding (Perkins, 1999). While this describes the barrier to acceptance of all threshold concepts, when considering evolutionary concepts, and specifically the reality of the evolution of the human species from previous "lower" life forms, the barriers can acquire special significance. Unlike other threshold concepts, accepting evolutionary theory often conflicts, not just with a previously held belief, but also with ideas that may form the very basis of a student's notion of themself. Put simply, there is no moral question when considering whether someone accepts the relationship between surface area and volume or other threshold concepts in biology (Ross, Taylor, Hughes, Kofod, et al., 2010). But accepting that our species is the product of a contingent, non-teleological process rather than a special act of creation can strike at the core of a person's self-perception, the meaningfulness of their life and their personal ethic.

There is thus a special challenge faced by teachers of evolution attempting to guide students through that "portal, opening up a new and previously inaccessible way of thinking about something" (J Meyer & Land, 2003), p.1). For this reason, providing a low-stakes environment in which students can wrestle with the concepts may be even more critical. We found success previously using a low-stakes environment (Wolf .& Akkaraju, 2014) when measuring student understanding of evolution. Application of the same model toward exploring acceptance seems logical to us.

We decided that our strategy would incorporate the non-overlapping magisteria (NOMA) framework for addressing the conflict between theological and scientific explanations for natural phenomena, popularized by Gould, (1997), who argued that:

> "The net of science covers the empirical universe: what is it made of (fact) and why does it work this way (theory). The net of religion extends over questions of moral meaning and value. These two magisteria do not overlap, nor do they encompass all inquiry..." (pg. 4)

NOMA has been recently endorsed by the National Academy of Sciences (*Science, Evolution, and Creationism*, 2008) and Eugenie Scott, the former Executive Director of the National Center for Science Education has argued against the "false dichotomy" of creationists versus evolutionists (Scott, 2000). Both of these institutions are dedicated to educating the U.S. populace on issues of science in general and evolution in particular. While we understand that NOMA is controversial in its own right, we felt it could be useful in our attempts to guide students toward accepting that we should appeal to scientific expla-

nations (versus theological or metaphysical) such as evolutionary theory when trying to study the workings of the natural world.

We also decided to introduce the concept of the nature of science (NOS) in these reflections, in order to allow students to explore the difference between scientific and non-scientific explanations of the natural world. It has been demonstrated that an understanding of NOS has a strong impact on the acceptance of evolutionary theory (Sinatra, et al., 2003).

Here, we describe our use of the blogging function within the Blackboard LMS as a liminal space. We explored the process of the acceptance of evolutionary theory in terms of a threshold experience as learners attempt to integrate their new knowledge with preexisting beliefs. More specifically we will report on how a series of ten online reflections (or blogs) can be effective in prompting learners to enter the liminal space and engage with challenging topics such as NOS, NOMA, and evolution.

Methods

We conducted our study at Bronx Community College in a single section of Introduction to General Biology, a mixed majors/non-majors course, taught by one of us (SA). In a previous work (Wolf. & Akkaraju, 2014) we piloted the approach of encouraging student participation in a discussion board style reflection on evolutionary theory. Here we present a refinement of this approach by taking into consideration the student's skill and experience in reflective thinking, motivation to reflect, and level of comfort in reflecting honestly (Stamper, 1996). To this end, we designed a series of ten reflection assignments to be rolled out over the course of the semester. Students were directed to complete a task (which typically involved watching an online video or PowerPoint presentation) on a specific aspect of evolutionary theory, nature of science, or the evolution-versus-creationism debate (Table 1). The videos for reflections 1-3, 5, 8 and 9 were from the *Evolving Ideas* series from the Public Broadcasting System (http://goo.gl/MEzIWl). Reflection 4 was from Khan Academy's *Evolution and Natural Selection* (https://youtu.be/Me_041nrRZk). Reflection 6 was a teaching module on NOMA that was developed by the authors as a PowerPoint presentation. Reflection 7 was from (Nadeau, 2014). Reflection 10 was from an episode of the PBS program by NOVA entitled, "Judgment Day: Intelligent Design on Trial" (https://youtu.be/7HZzGXnYL5I).

After completing the task, students were required to post a response/reflection on the Blackboard campus pack blog tool hosted on our Blackboard LMS. The prompts provided for completing the reflections were identical from week to week (except for reflection 10) and asked students to first summarize the viewing, then interpret it, and finally respond to it emotionally (Table 2).

Instructions for the reflections along with a grading rubric (See Table 3) were posted in a folder within the Blackboard system and each reflection assignment became available to

Table 1: Reflection Topics.

	Topic	Type of Presentation
1	Nature of Science	"Isn't Evolution Just a Theory?" (video clip)
2	Evidence of Evolution	"How do we know evolution happens?" (video clip)
3	Evolution vs. Creationism	"Why is Evolution Controversial Anyway?" (video clip)
4	Process of Evolution	"Natural Selection" (video clip)
5	Evidence of Evolution	"What is the Evidence for Evolution?" (video clip)
6	Evolution vs. Creationism	NOMA (instructor-developed PowerPoint module)
7	Evolution vs. Creationism	"Even the Pope isn't a Hardcore Creationist" (news item)
8	Human Evolution	"Did Humans Evolve?" (video clip)
9	Evidence of Evolution	"Does the theory of evolution really matter?" (video clip)
10	Evolution vs. Creationism	"Intelligent Design on Trial" (video clip)

Table 2: Reflection Prompts.

Reflection	Type of Prompt	Reflection Prompts
1 - 9	Task	Watch the presentation titled ...
	Description	What were the most important ideas?
	Interpretation	The most meaningful aspect of the video was ... Before I watched this video, I never knew that ...
	Outcome	Having watched this video clip I now realize that ... This video makes me think/feel ...
10	Task	Watch the video "Intelligent Design on Trial"
	Description	Explain the idea of NOMA (Non Overlapping Magisteria) proposed by Stephen Jay Gould about religion and science.
	Interpretation	What are your thoughts on this controversy based on what you have learned about Non-Overlapping Magisteria (NO-MA)?
	Outcome	How would you vote if your child went to a public school in Dover? Would you vote to have Intelligent Design taught in the science classroom? Do you consider Intelligent Design a scientific theory?

Table 3. Student Reflection Rubric.

Criteria	Beyond expectations	Meets expectations	Below expectations
Description	Describes the overall idea of the presentation correctly and includes all the main elements.	Describes the overall idea of the presentation correctly but leaves out one important element.	Presents the overall idea with some errors and leaves out two or more important elements.
Interpretation	Explains the most meaningful aspect of the presentation with appropriate detail and explains why it was meaningful.	Explains the most meaningful aspect of the presentation with some detail and explains why it was meaningful.	Does not provide sufficient detail to explain the most meaningful aspect of the presentation and does not explain why it was meaningful.
Outcome	Explains emotional reaction to the presentation using appropriate language and level of detail. Writing reveals deep engagement with the topic	Explains emotional reaction to the presentation using appropriate language and some detail. Writing reveals moderate engagement with the topic	Does not explain emotional reaction or does not use appropriate language or details. Writing reveals only superficial engagement with the topic.
Fluency	Writing is free of grammar, punctuation, and spelling errors	Writing is mostly free of grammar, punctuation, and spelling errors	Writing has too many grammar, punctuation and spelling errors that is distracting to the reader.

the students sequentially as the semester progressed. Students were graded on their level of engagement with the topic rather than the correctness of their response. The students used the blog tool in Blackboard to submit their assignments. By a majority vote the students decided that these blogs should be made visible to all students in the class and not just to the instructor. Instructor feedback was also visible to other students although the grade for each reflection was kept private. Even though the blogging environment was designated as the primary liminal space, occasionally discussion of these topics would spill over to the classroom, which then served as the secondary liminal space. At the end of the semester, student reflections were provided codes to anonymize them and they were catalogued so that both authors could analyze them independently.

Results

A total of 20 students participated in the reflection assignments and there were an average of 17.7±1.3 (SD) responses per reflection. The difference reflects the fact that 2 students

ceased to participate in the reflection blogs. We analyzed student reflections by: a) examining each student's excursive and/or recursive journeys through the liminal space while highlighting the troublesome and transformative elements of this threshold experience; (b) exploring the degree of acceptance and integration of evolutionary theory among the students engaged in reflective writing; (c) identifying key concepts that were presented in each assignment and assessing student level of engagement and understanding.

We followed each student's unique liminal journey and recorded any troublesome and/or transformative elements of the threshold concept that might have been experienced (Figure 1). Except for one student (Student E) who began this journey from within the liminal space and crossed the threshold with ease, all other students began at the pre-liminal stage. A total of seven students (A, B, C, E, J, S, and T) crossed the threshold and entered the post-liminal state. The remaining 13 students were in different stages of liminality by the end of the semester. Overall, we captured 29 troublesome instances and 37 transformative instances experienced by this group of students (Figure 1).

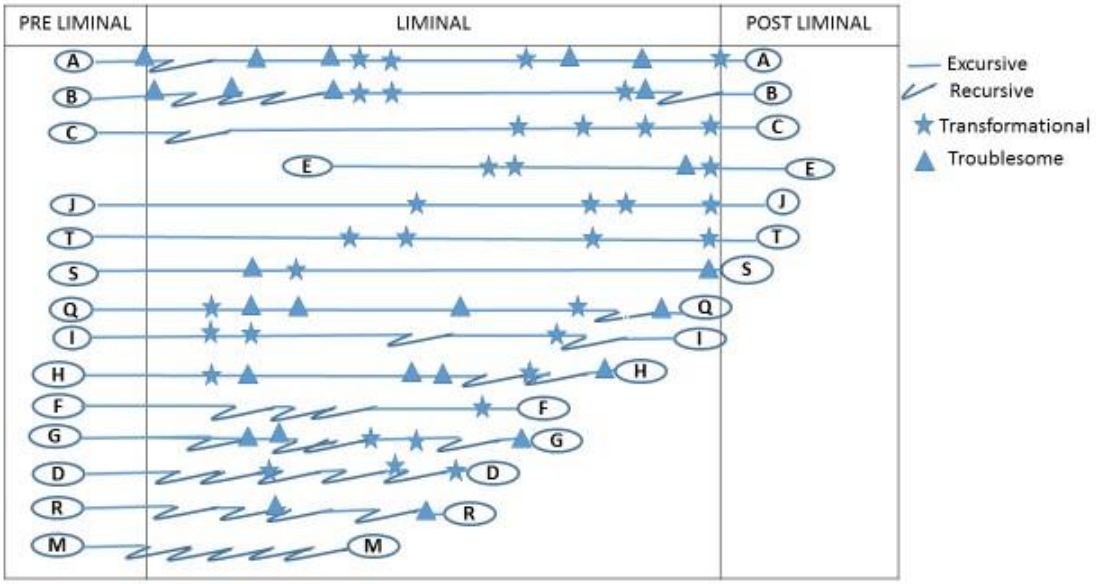


Figure 1: A snapshot of the liminal journey undertaken by 20 students

In the case of evolution, many students are simply unaware of the sheer amount of evidence that supports it and so when faced with a piece of new information they may find it overwhelming or just far-fetched. In Table 4, we present some examples of troublesome aspects related to the acceptance and integration of evolution. Students A and Q had trouble with the NOS, a concept that appears to be fairly straightforward but contains nuances that are not always obvious to the novice learner. This knowledge is therefore tacit or implied. Both students have trouble distinguishing an everyday guess, a scientific theory, and a philosophical idea. The concept of NOMA appears to be fairly straightforward but it too can be troublesome for the learner who does not get all of the nuances. Student I clearly explains NOMA but misuses the word "belief" when talking about evolution, a

Table 4: Troublesome areas in the acceptance of evolutionary theory

Troublesome area	Why is it troublesome?	Excerpt of student's writing
Nature of Science: Inability to differentiate between a scientific theory and an everyday guess	Alien concept Tacit	Student A: *"Evolution provides something many other things don't which is hard, cold evidence instead of theories and ideas that are spoken and never seen first -hand*."
Evidence of Evolution: Trouble accepting the scientific fact that fish have evolved from worm-like ancestors.	Overwhelming and therefore appears to be far-fetched	Student A: *"This video makes me think just how weird this world is and how complex it is to understand. While ultimately this idea is not a 100% proven fact it is strongly supported and believable, but to think that things such as fish come from the likes of worm is an overwhelming statement and can make you wonder just how much of this world do we really understand; if anything at all."*
NOMA: Usage of the word "belief" in relation to evolution.	Tacit	Student I: "*…scientific ideas and observation will not be able explain the existence of God. On the other hand, religious beliefs will not be able to prove science is wrong based on spiritual ideas or symbols. It was really interesting to learn that religious* ***people can believe in evolution*** *without interrupting their religious beliefs."*
Evolution vs. Creationism: Struggling with the idea of whether or not to include creationism in the classroom **&** **Nature of Science** Unable to differentiate between a scientific theory and a philosophical idea.	Learner Defended Alien concept	*Student Q:* *With NOMA in mind, I think that there has to be a clear separation between science and religion… I don't think that it would be good to limit children's curiosity with only one theory but we need to mention the separation or difference between science and religion, just as NOMA suggests. I think that if I had a child studying in Dover I would vote in favor to have Intelligent Design mentioned in the science classroom as another theory BUT not taught in density as evolution should be.* ***I remember when I was in high school*** **[sic]***,* ***my biology book had the creationism as another scientific theory of the origin of life****. Even though, there was only a paragraph in creationism and a complete chapter in evolution. I think that was actually a very good and balanced way of presenting both points of view.* ***For me I don't think it would harm a child to know the theory of creationism as another theory****. The problem is when professors are biased and* ***don't***

	know how to distinguish between a theory and a fact. Honestly, I don't know if I consider Intelligent Design a scientific theory, because I don't think there's actually any scientific evidence to support it. *The idea challenges me because I have always believed that creationism needs to be known. Anyways, I recognize that when talking about education, in science we need to leave our feelings outside and open our minds to the evidence.*

common misconception (Smith, 1994). An example of troublesomeness arising from the knowledge being overwhelming and therefore appearing to be far-fetched is clearly demonstrated in the writing of Student A. Acceptance of evolution can be an issue if the learner is "defended" by strong prior beliefs and ways of thinking. Student Q's almost poignant reflection on the evolution versus creationism debate in Dover is a classic example of the struggle arising from the learner that remains defended. The student stays deeply engaged throughout and yet, is learner defended as demonstrated by the oscillation between moments of clarity and confusion.

A concept is transformational when it produces a paradigm shift resulting in new ways of thinking about something (Meyer & Land, 2003). Examples of transformative moments are shown in Table 5.

When the analyzed the reflections to gauge student responses to specific concepts that were presented, including the evidence for evolution, the evidence for human evolution, natural selection, common ancestry of extant species, and evolution generally. We reasoned that expression of positive views about these topics would, in itself, be a positive indicator of a move toward acceptance. We found a range of 85% (natural selection and the common ancestry of all living things) to 100% (the evidence for evolution) for students expressing positive views (Figure 2).

We then examined the reflections to gauge whether students understood two concepts in particular, the NOS and NOMA. We found that 70% of students displayed an understanding of the NOS (Figure 3A) and 75% evinced a comprehension of NOMA. (Figure 3B).

In the final reflection, which had an 85% response rate, students were asked to view "Judgment Day: Intelligent Design on Trial" from the PBS program NOVA, which explains the history of the *Kitzmiller v. Dover Area School District* lawsuit regarding the teaching of intelligent design (ID) in the science classroom. After viewing, students were asked a number of reflection questions (Table 2) including whether they would vote to allow ID to be taught in a science class, to which 73% (11/15) responded that they would vote against such a proposition (Figure 4A). When we aligned student responses to the ID question with their understanding of the NOS and NOMA we found a general concordance. 100% of students who displayed an understanding of both concepts voted against

Table 5: Transformative areas in the acceptance of evolutionary theory

Transformative area	Excerpts of Student Writing
Evidence of Evolution	Student D: "*Having watched this video clip I now realize that when something doesn't make sense evolution most likely can answer the question. This video makes me think evolution is everywhere*" Student K: *Before I watched this video I never knew that the further we go back in time, the harder it should be to distinguish whales from normal land mammals. Having watched this video I now realize that thousands of observable facts, from completely different fields of study, have come together to tell us the same story. This video makes me feel that I have so many things to learn from theories and that there is plenty of evidence to evolution.*
Human evolution	Student J: *"For me the more meaningful aspect is that by pairing DNA sequence from different species we can obtain the relation proximity and know how long ago a common ancestor existed. Before I watched this presentation, I've always heard people claiming that humans evolved from Chimps. Now I clearly understand that, it is not that we evolved from chimps but that we are closely related by sharing a common ancestor"*
Interconnectedness of life	Student Q: *This video makes me think about the animal nature of humans. The reason I think about this is because of the similarities found between all mammals. I think people don't like to imagine themselves as part of the animal kingdom because they think that would made them less capable of reason. In my opinion, it is actually exciting to think about me as part of the biggest family ever.*
Integration of Evolution with personal beliefs	Student P: "*Another interesting fact discussed in the video is that the first book of the Bible doesn't really explain how exactly God created the substances with detail. In other words, there is no logical explanation… This caught my attention because I never really asked myself any of these questions of how things came to be; I just followed and believed my parents' beliefs! I never knew there actually existed a legal battle between whether or not to teach evolution and Darwin's origin of species! Having watched this video I now see how important it is for us to be open minded as human and be able to understand that one thing (science and evolution) doesn't have to affect the way you view the other (theology and personal beliefs)."* Student I: *"I was born and raised Muslim. It is still hard for me to believe that evolution is real. However, as a biology student and after reading and watching these videos about evolution I can comfortably agree with the idea*." Student E: "*This presentation was particularly interesting to me because I grew up in a very religious household. The idea that science and religion can coexist and the Catholic Church has accepted that idea is really amazing and new to me. Having the wisdom to understand that knowledge is important and not a threat to theology is very important. Before reading*

> *this I never knew that it was in the 1950's when the Catholic Church came out in acceptance of the theory of evolution. The most important part about this presentation is how it points out that science and theology, though they do help us understand very similar aspect of humanity, they don't overlap*."

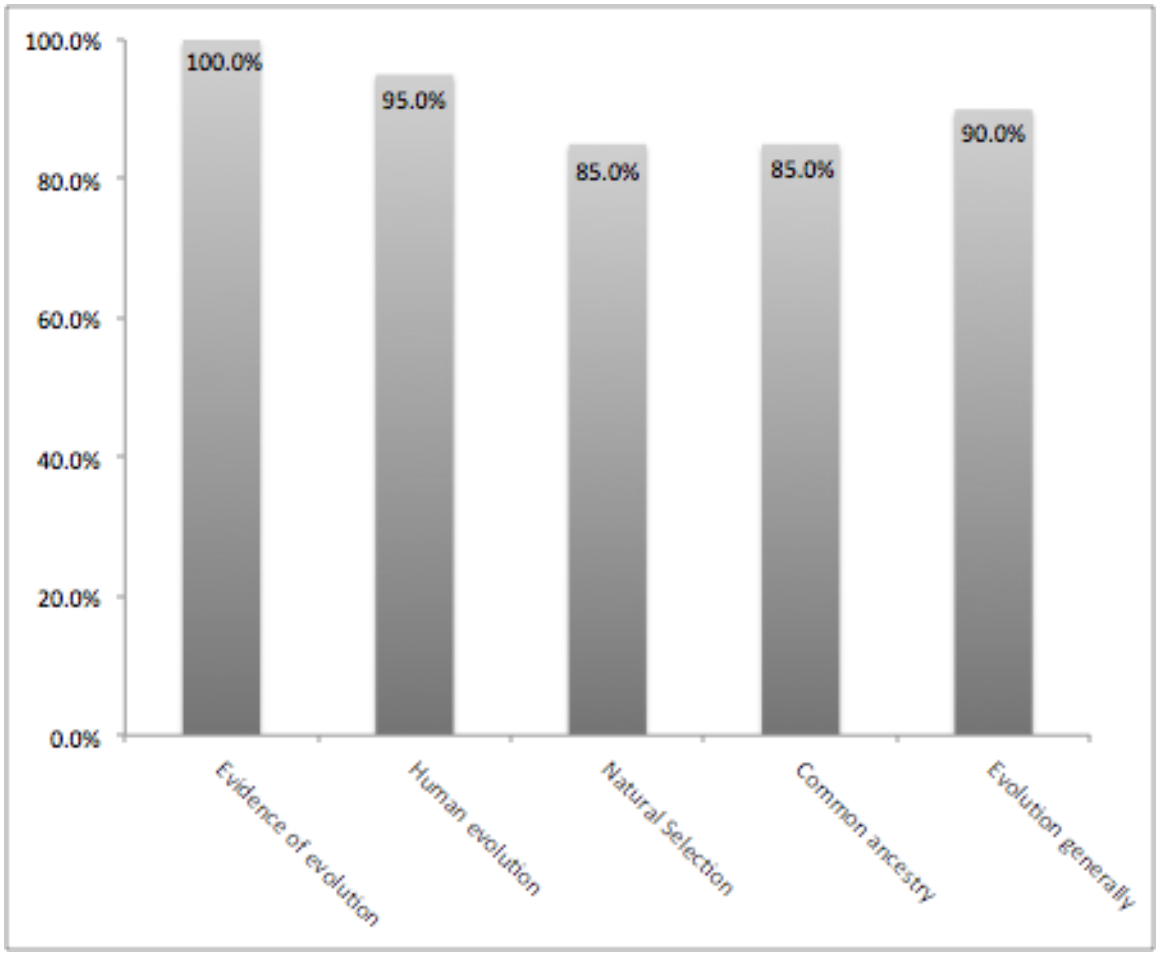


Figure 2. Percentage of students offering positive views on various topics related to evolution.

teaching ID in science class. Meanwhile, 80% of students who failed to understand either the NOS or NOMA (or both) voted to include ID instruction in the science classroom (Figure 4B).

Discussion

As in other studies (Wood, 2012), we found that the blog-as-liminal-space format served our students very well, based on the level of participation and the degree to which most students submitted thoughtful and well-developed reflections. We feel that it is critical to

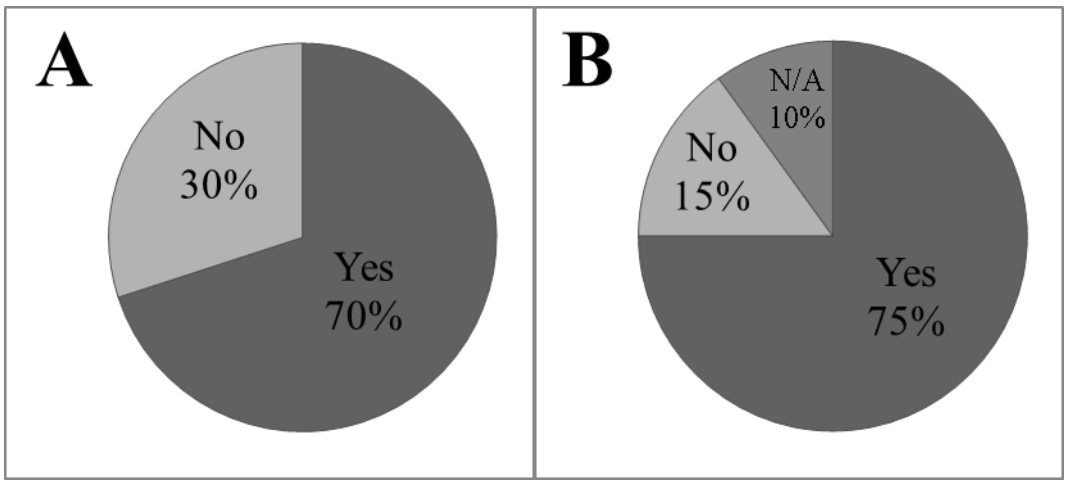
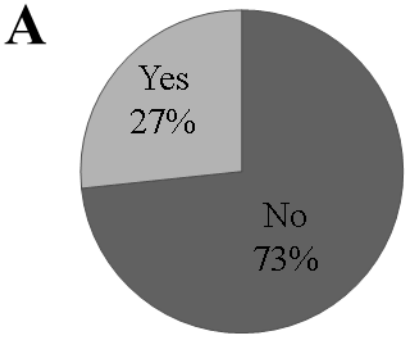


Figure 3. Student understanding of NOS and NOMA. Analysis revealed that 70% of students displayed an understanding of the NOS (A) while 75% submitted reflections that indicated an understanding of NOMA (B).

Should intelligent design be taught in the science classroom?



B	Displays an understanding of the NOS	Fails to understand the NOS
Displays an understanding of NOMA	No: 10 Yes: 0	No: 1 Yes: 1
Fails to understand NOMA	No: 0 Yes: 2	No: 0 Yes: 1

Figure 4. The relationship between understanding of the NOS and NOMA and education policy decisions. In the final reflection, 73% (n = 15) of students voted to exclude ID from the science classroom (A). 100% of students who display an understanding of the NOS and NOMA voted to exclude intelligent design from the science classroom, while students displaying a lack of understanding of either or both are more likely to vote to include ID in the science classroom (B).

assess these types of assignments on participation only. The liminal journey is messy and involves excursions to new ideas and retreats to previously held, perhaps incorrect, notions. Therefore, students must not feel that they will be judged negatively for expressing these things. Using carefully designed reflection prompts on sequential topics can provide the instructor with a window into the student's liminal experience. Straightforward tasks such as watching a short video clip coupled with specific prompts that are predictable from week to week (see Table 2) help to keep students not skilled in reflective writing

motivated and engaged in this process. Indeed, we found that it was relatively straightforward to observe students as they wrestled with the troublesome areas involved in the acceptance of evolutionary theory (Table 4). We were also able to observe when students experienced the sorts of transformations that occur when dealing with a threshold concept (Table 5).

We believe that the introduction of NOMA as one of the reflection topics may have assisted in this integration. The National Academy of Sciences essentially uses the concept to address the evolution versus creationism debate:

> "Science and religion are based on different aspects of human experience. In science, explanations must be based on evidence drawn from examining the natural world. Scientifically based observations or experiments that conflict with an explanation eventually must lead to modification or even abandonment of that explanation. Religious faith, in contrast, does not depend only on empirical evidence, is not necessarily modified in the face of conflicting evidence, and typically involves supernatural forces or entities. Because they are not a part of nature, supernatural entities cannot be investigated by science. In this sense, science and religion are separate and address aspects of human understanding in different ways. Attempts to pit science and religion against each other create controversy where none needs to exist." (*Science, Evolution, and Creationism,* 2008)

In consideration of the fact that the majority of our students come from religious backgrounds, we exposed them to the concept of NOMA and allowed them to explore its meaning and apply it to the specific situation of intelligent design in the classroom. They were asked to vote whether or not to keep include intelligent design in the classroom and explain their stance on this issue. Since this was the last reflection, only 15 out of 20 students submitted a response. 73% of these students voted to **not include** intelligent design in the science classroom and those that wanted to include intelligent design in the classroom had trouble with either their understanding of NOMA, the nature of science or both (see Figure 4).

Our data showing the correlation between understanding of the NOS and NOMA and the decision to keep ID out of the science classroom is noteworthy, though our small sample size requires further confirmation (Figure 4). We surmise that this finding points to the importance of understanding the NOS in order to differentiate evolution from non-scientific explanations. And thus, in order to apply NOMA to issues of creationism in the classroom, it is necessary for the student to understand the nature of science. Indeed, it has been shown that an understanding of NOS can increase the acceptance of evolutionary theory (Sinatra et al., 2003). This finding also makes it clear that our study could've benefitted from additional learning opportunities for the NOS, a concept that is troublesome because it is frequently alien to undergraduates and also heavily nuanced. (See Deng, Chen, Tsai, & Chai, (2011) for a recent review of the state of undergraduate conceptions of the NOS) This is an area that will be strengthened considerably in future semesters.

Our data recapitulate the common sense notion that not all students enter a classroom at the same stage of understanding, regardless of the course or topic at hand. Uneven development and student history ensures a wide range of starting points with a certain degree of pre-liminal variation (Jan Meyer & Land, 2006). The blog-as-liminal-space course design is well suited to this reality, as it allows students to move through the liminal space at their own pace, however imperfectly, confronting the aspects that they find troublesome.

The blog format was particularly effective in revealing weaknesses in student understanding that can be addressed via other types of interventions. For example, student reflections clearly showed us that in order to make an informed decision regarding intelligent design in the curriculum, they will have to demonstrate a firm understanding of both NOS and NOMA. A learning opportunity targeting the mastery of these two concepts with a benchmark of 90% would go a long way in ensuring that the student is well informed before making a decision. This is also an opportunity to teach students how to think about an issue and form an opinion based on fact. In future semesters, this intervention will be constructed such that students continue to feel comfortable explaining their vote on ID in the classroom in a fully supportive liminal environment.

Although this report is based on only one semester's experience, we feel that using online tools such as blogs or discussion boards can be an extraordinarily useful tool for guiding students through the liminality of acceptance and appreciation of evolutionary theory.

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