Medical Student Motivations, Persistence, and Design Factors in Foundational Science Online Learning Modules: A Qualitative Study

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This Thesis, Medical Student Motivations, Persistence, and Design Factors in Foundational Science Online Learning Modules: A Qualitative Study presented by Eric Gantwerker, and Submitted to the Faculty of The Harvard Medical School in Partial Fulfillment of the Requirements for the Master of Medical Sciences in Medical Education has been read and approved by:

Richard Schwartzstein

Eric Klopfer

Justin Reich

Date: April 25, 2017
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Date: April 25, 2017
Medical Student Motivations, Persistence, and Design Factors in Foundational Science

Online Learning Modules: A Qualitative Study

Abstract

Limited research exists on the intersection of medical education, e-learning, and motivation. To better understand this intersection, a qualitative study was conducted with pre-medical students following exposure to a new online learning course designed to teach basic science in the context of medicine. A total of seventeen, one-hour semi-structured interviews were conducted on medical, dental, and graduate students exposed to the curriculum.

Research questions focused on initial motivations to engage with the material and, for those who completed the coursework, what motivated them to persist to completion. The interviews were coded and categories and themes were generated. Analysis revealed motivations ranging across the spectrum of extrinsic to intrinsic and included elements of a sub theory of motivation entitled organismic integration theory (OIT). Organismic integration theory (OIT) is an autonomy based continuum within extrinsic motivation that includes external regulation, introjection, identification, and integration. Findings suggest that initial motivations to engage in the online material were on the lower end of autonomy of the OIT continuum, but following exposure to the modules, students noted elements of more autonomous motivations that specifically led them to persist. They mention design factors such as varied multimedia elements, real-life examples, interactive virtual scenarios, instructor-led segments, interspersed knowledge assessments with immediate feedback, and real medical scenarios, patients, and equipment. Students explained that these design factors facilitated their learning and enhanced their enjoyment of the material, ultimately moving them towards completion. Although this study described a small group of self-selected students, it represents an important subgroup of learners in this space. Also, this is one of only a select few qualitative studies on the intersection of medical education, e-
learning, and motivation. This pilot study is poised to stimulate more research into this area to better elucidate motivations in medical students with the goal of improving the design of online learning experiences either as a stand-alone or as part of a blended learning model.
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Figure 2A. Diver mystery scenario animation at the beginning of the partial pressures physiology lesson. It tells of a diver and her father going scuba diving. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.

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Figure 7. Summary of participants.

*Definition of persistence - For this initial course offering, students could not qualify for certificates and there were no final exams in the courses, so the statistic used for persistence was completion of the final lesson of the course. These data were based on assessments built into the course, thus "starting" the course is defined as attempting at least one assessment in the course, and persisting to the last lesson is defined as attempting assessment in the final lesson of the course. These data only address the course use during the summer of 2015; however, these students retained access to the courses for several months afterwards.
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1.0 Introduction

1.1 Background and Rationale

American medical education has been under the magnifying glass ever since Abraham Flexner’s scathing report in 1910 entitled *Medical Education in the United States and Canada* (Ludmerer, 1999). The Flexner Report, as it came to be known, led to a complete overhaul of the medical education system, resulting in a large influx of educational funding, higher standards, and better-defined curricula that brought medical education to the level that as it is known today (Cooke, Irby, & O’Brien, 2010; Ludmerer, 1999). The traditional medical school model was thus defined, which consisted of two years of pre-clinical education followed by two years of clinical (direct patient care) education. The Carnegie Foundation commemorated the 100th anniversary of the Flexner Report by seeking to delineate the new challenges that face 21st Century medical education (Cooke et al., 2010). In their summary, the Carnegie researchers explained that time and funding were at a premium and to efficiently and effectively train competent and compassionate physicians there must be “new curricula, new pedagogies, and new forms of assessment” (Cooke et al., 2010; Hollands & Tirthali, 2014; Mullaney, 2014).

Concurrent to the focus of revamping medical education curricula, there have been major advances in the realm of educational psychology and conceptual frameworks for motivation, but limited research and application have been seen in medical education (R. A. Kusurkar, Croiset, Mann, Custers, & ten Cate, 2012). Kusurkar et al. discussed the role that motivation can have on the success of educational curricula and principles that can promote intrinsic motivation. These elements included “autonomy support, adequate feedback, and emotional support” (R. A. Kusurkar et al., 2012). These principles align with what Knowles et al. discuss as adult learning theory (ALT) or andragogy. Several principles are described by Knowles et al. that are core to andragogy: the need to know, the self-concept of the learner (autonomy), the role of past experiences, the willingness to learn, orientation to learning, and
motivation (Knowles, Holton, & Swanson, 2011; Severino, Aiello, Cascio, Ficarra, & Messina, 2011). In line with these above principles, medical schools have attempted to improve contextualization of learning and engaging student doctors in early patient care. To achieve this, several medical schools around the country have started by decreasing their pre-clinical instructional time, reducing a previous two-year curriculum into 12-18 months of instruction. This allows for an expanded patient exposure time and often increased time for career exploration and research (autonomy). With decreased classroom time, medical schools have looked to content delivery outside the classroom, reserving residential instructional time for critical thinking and content application.

The concept of content delivery prior to in-class discussion has been termed flipped classroom. This flipped classroom concept is by no means new; elements of it date back 70-80 years (Armstrong, 2015). In the flipped model, content can be delivered in several ways including articles, cases, videotape lectures, and, more recently, e-learning modules. Various forms of e-learning have been implemented across the United States to help bring medical education into the 21st century both as stand-alone instruction and as part of the flipped classroom model. The flipped model heavily relies on the students themselves to complete the pre-work prior to engaging in the classroom, which relies on student motivations. The heavy reliance on self-regulated learning processes leads to many discussions that focus on motivation and learning strategies.

Online learning, or e-learning, has been increasingly relied upon in medical education as part of a blended or as a stand-alone learning model. Medical education is continually adapting in the 21st Century as it seeks to train today’s student doctors, who themselves are digital native learners. First year medical students starting in Fall 2017 would have been born as early as 1995. This was the year that Windows 95™ came out, eBay™ started, and Disney’s Pixar™ movie Toy Story was released (“The Year 1995 From The People History,” n.d.). As the
educational system seeks to train these digital natives, there exists the need to re-examine pedagogy/andragogy and the motivations that may drive this new-age learner group. The Association of American Medical Colleges (AAMC) developed a group, named the Institute for Improving Medical Education (IIME), to look at improving medical education in the digital age. In their 2007 report *Effective Use of Educational Technology in Medical Education*, they discussed several important strategies for introducing educational technology including computer aided instruction (CAI), virtual patients, and human patient simulation. The strategies described address methods to gain attention of the users, to construct objectives, to stimulate prior knowledge, to use Mayer’s principles for material presentation, to provide guidance in learning, to make learning more active by introducing cases and problems, to provide feedback, to assess performance, and to enhance retention and transfer (Chandler, 2007). Of note, for the purposes of this paper, reference to educational technology, online learning, e-learning, and technology mediated learning, will be focused on human-computer interactions within an online learning environment. This is often referred to as computer aided instruction (CAI), which is separate from learning management systems (LMS) such as Blackboard™, Moodle™, and Canvas™.

Online learning in general education has received attention in recent decades due to increased class sizes, cost concerns, and a popularization of personalized learning. A sizeable portion of e-learning research has been done on large scale online courses or Massive Open Online Courses (MOOCs). MOOCs began with a single course at a single institution around 2011. At the close of 2015, according to data by Class Central, MOOCs are now offered at over 500 universities, encompassing over 4200 courses, and providing education to over 35 million students (Shah, 2015). Much of the early literature on MOOCs focused on the low completion rates, ranging from 2-10%, prior to earning a certificate (Lynch, 2016; Reich, 2014). Multiple studies since have focused on intention and motivation, which showed that students have
different goals or intentions for partaking in the educational material other than receiving a certificate or completing the material (Reich, 2014).

In 2013-2014, Reich et al, introduced a survey into HarvardX courses to further probe completion and retention as a function of student intent. They surveyed students to find out their intent in the coursework, and subsequently categorized students as completers, auditors, browsers, and unsure. They then looked at persistence and completion and found that 22% of students with an intention to complete did go on to achieve their certificate. They also found that attrition rates rise sharply in the first 1-2% of the course (Reich, 2014). They go on to discuss design implications that include engaging students early and often and creating a sense of community to improve persistence. This concept of autonomy and relatedness as a function of engagement has been studied in residential and general education environments in multiple investigations (Niemiec & Ryan, 2009). Despite this, motivation in online learning has only recently been gaining attention as educators and institutions try to tailor the online learning experiences to engage learners. Although there have been several studies on motivation in online learning, the medical education literature on this topic has largely been sparse (R. A. Kusurkar et al., 2012; Vermunt, 1996).

Deci and Ryan have written extensively on motivation and describe the spectrum from amotivation (lack of motivation) to extrinsic motivation to intrinsic motivation. Intrinsic motivation is the desire to perform a task due to the inherent enjoyment and desire within the task itself. Extrinsic motivation is the desire to perform a task due to factors external to the task such as rewards or avoidance of punishment. Deci and Ryan also described the organismic integration theory (OIT), which described four separate types of extrinsic motivation: external, introjection, identification, and integration. Organismic integration theory (OIT) also described different factors that inhibit or promote integration and internalization of the regulation of behaviors (Ryan & Deci, 2000). Intrinsic and extrinsic motivations, in turn, inform self-regulated learning (SRL)
processes, which are defined as the “self-directive process[es] through which learners transform their mental and physical abilities into task-related skills” (S. Malau-Aduli, Page, Cooling, & Turner, 2013; B. J. Zimmerman, 2001). Learners who are highly self-regulated are said to be “metacognitively, motivationally, and behaviourally active participants in their own learning processes” (White, Gruppen, & Fantone, 2014; Barry J. Zimmerman, Heart, Mellins, & Zimmerman, 1989). In the online learning space, it is essential to understand the motivational underpinnings and self-regulated learning processes to effectively engage students in the learning experience.

Based on the limited research at the intersection of e-learning, medical education, and motivation, this study was designed to better understand these concepts as they pertain to medical students. The research setting comprised optional online foundational basic science modules developed for Harvard Medical School (HMS) students to take the summer prior to beginning medical school. In Fall 2015, HMS implemented a new curriculum entitled Pathways. In this new curriculum, students are engaged in a shorter amount of pre-clinical time, initially going from two years down to 14 months, followed by clinical training during the remainder of the second year. With less time allocated to pre-clinical education, concerns arose that some students may not have the foundational basic science knowledge to support an accelerated curriculum. The HMX modules, as they became known, were developed to fill this gap. The research was thus conducted with the students involved in this Foundational Concepts in Medicine computer assisted instructional experience.

As this was optional, students may have various motivations to initially engage in this platform and to persist through the material to completion. A qualitative study was undertaken with these students following the course completion utilizing semi-structured interviews to better understand their thought processes and motivations. Through these interviews, several design elements were discussed that contributed or detracted from motivations to persist through the
material. Through this research, improved understanding of motivations and online learning experiences may allow better tailoring of these experiences to increase efficacy, efficiency, and engagement of learners. This research is unique in that it is a qualitative study looking at e-learning with medical students. Design elements discussed herein, once better understood, may be implemented as part of a flipped classroom model or stand-alone curriculum, to facilitate and foster the integration of regulatory mechanisms in learning. Intentional design incorporating these factors may lead to greater enrollment, retention, and completion of these online learning experiences. The results of this research may trigger further studies into motivation amongst medical students and can have far reaching implications for the design and advancement of technology enhanced, and mediated, medical education.

1.2 Theoretical Framework

Motivation is a wide and diverse concept. Several different relational constructs describe the underpinnings of motivation. Deci and Ryan describe self-determination theory (SDT), intrinsic and extrinsic motivation, and organismic integration theory (OIT). These concepts in turn were built upon by B.J. Zimmerman who described self-regulated learning (SRL) processes and A. Bandura who described self-efficacy (SE). Carol Dweck has written extensively about the growth mindset that has led to discussions of performance and mastery goal orientations. Knowles et al. has written extensively about adult learning theory (ALT) or andragogy.

1.2.1 Self-Determination Theory (SDT)

Self-Determination Theory (SDT) states that “human beings have a natural tendency to develop autonomous regulation of behaviour and are intrinsically motivated to learn and to take on challenges” (Ryan & Deci, 2000; Ten Cate, Kusurkar, & Williams, 2011). SDT has been well described by Edward Deci and Richard Ryan who are considered the foremost experts on intrinsic and extrinsic motivation. They state that “self-determination theory emphasizes that
learners who are intrinsically motivated embrace learning as a valued activity in and of itself, regardless of rewards or outcomes" (Ryan & Deci, 2000; White et al., 2014).

1.2.2 Motivation and Organismic Integration Theory (OIT)

Deci and Ryan have written extensively about motivation and its implications. Intrinsically motivated individuals are those that “embrace learning as a valued activity in and of itself, regardless of rewards or outcomes” (Ryan & Deci, 2000; White et al., 2014). The key to extrinsic motivation is that the performance of tasks is motivated by things extrinsic to the behavior, whether they are outright rewards or the instrumental value of the task. These are defined separately from intrinsic motivation, which is limited to those who undertake the task due to the inherent enjoyment of the task itself. As a subset of motivation Deci and Ryan describe the Organismic Integration Theory (OIT). According to the OIT, they describe four types of extrinsic motivations moving from least autonomous to most [Figure 1]. Along this continuum includes external regulation, introjection, identification, and integration (Ryan & Deci, 2000).
Figure 1. Organismic Integration Theory (OIT). On the spectrum from amotivation to extrinsic to intrinsic motivation, there are varying levels of autonomy as the locus of causality changes from external to internal. Adapted from Fig.1 A taxonomy of human motivation. (Ryan & Deci, 2000)

1.2.3 Self-Regulated Learning (SRL)

Self-regulated learning (SRL) is defined as the “self-directive process through which learners transform their mental and physical abilities into task-related skills” (S. Malau-Aduli et al., 2013; B. J. Zimmerman, 2001). Intrinsic motivations to learn on one’s own are predicted by “personal control, competence, [and] interest in a task” (B. J. Zimmerman, 2001). Learners who are highly self-regulated are said to be “metacognitively, motivationally, and behaviourally active participants in their own learning processes” (White et al., 2014; Barry J. Zimmerman et al., 1989). They are processes, not attributes or personality traits, and thus possess no true dichotomies in its description (B. J. Zimmerman, 2001). Zimmerman divided self-regulatory processes into three different phases: forethought, performance, self-reflection. Different strategies are used in difference phases, with expert learners tending to be more proactive in their learning processes and they plan learning experiences as opposed to those who are more reactive. The concept of SRL has been discussed in medical education by White et al. who developed a four-phase description of planning, learning, assessment and adjustment (White, Gruppen, & Fantone, 2013).

1.2.4 Self-Efficacy (SE)

Bandura et al. discuss the concept of self-efficacy (SE) that has been tied to self-regulated learning theory as a “task-specific motive for learning.” It is essentially one’s belief in their ability to perform a certain task. Self-efficacy contributes to the forethought phase of self-regulated learning, namely, if one has low self-efficacy in a certain task, one will enact processes at this phase to improve one’s knowledge and abilities. Metacognition is essential in
understanding one’s own self-efficacy and directing learning processes in the forethought phase and contributes to engagement in learning tasks. Other self-motivational beliefs include intrinsic interest and outcome expectations. Expert learners who employ strong self-regulated processes tend to show strong “personal initiative, perseverance, and adaptive skill” in pursuing learning experiences (Severino et al., 2011; White et al., 2014; B. J. Zimmerman, 2001).

If one has low SE, the planning phase of SRL will be affected. If the self-assessment is accurately calibrated, students will seek out information to improve their SE. This leads to goal development based on motivation. If the motivation is intrinsic, then the students have a genuine interest and enjoyment inherent to learning and becoming an expert in the subject area, this leads to a mastery goal orientation. On the other hand, extrinsic motivation means that some outcome separate from the actual learning is driving information seeking behavior. Extrinsic motivation leads to more performance goal orientation, meaning that students engage in material with the goal of improved performance on assessments and in front of faculty and peers (B. J. Zimmerman, 2001; Barry J. Zimmerman et al., 1989).

There are other factors that influence goal setting including personal and social-environmental factors. Personal factors include historical performance, skill level, values, attributions, and self-efficacy. “Self-Efficacy is the most important influence on personal goal setting” (White et al., 2014). Social-environmental factors include the normative environment, peer groups, role-modelling, and feedback (White et al., 2014). Each of these factors affects the degree of challenge embedded within one’s goals. In other words, if a normative environment changes (such as from a college setting to a medical school setting), then it will in turn affect one’s goal setting.
1.2.5 Views of Intelligence and Goal Orientation

Carol Dweck discusses the concept of entity and incremental intelligence views. Entity viewers believe that you are born with a certain level of intelligence and you cannot increase this over time. Those who ascribe to an incremental view believe that intelligence can change over time (Dweck, 1986). Goal orientation was introduced by Locke and Lathan in the 1970s and 1980s. They disclosed that “setting specific, proximal, challenging but attainable goals greatly influenced the effectiveness of learners’ efforts to learn” (B.J. Zimmerman, 2001).

Dweck and others went on to expand on goal orientation and described a dichotomy between mastery and performance goal orientation. Dweck discussed further how these views of intelligence affect goal setting and learning behaviors. They describe that entity learners are often more performance goal oriented versus incremental learners are often more learning (mastery) goal oriented. They found that students who were mastery goal oriented tended to show higher motivation, effort, and persistence during self-directed learning experiences (Dweck, 1986). Performance goal orientation tended to show less of these behaviors (B.J. Zimmerman, 2001). Zimmerman summarizes it best: “self-regulated learners are distinguished by their personal initiative and associated motivational characteristics, such as higher self-efficacy beliefs, learning goal orientations, favorable self-attributions, and intrinsic motivation, as well as by their strategic and self-monitoring competence” (B.J. Zimmerman, 2001).

M.C. Zimmerman discussed in 2002, during the infancy of online learning, that self-regulated learning theory predicted persistence and attrition in higher education, web-based courses. She discussed that self-regulation is a predictor of achievement and most importantly, it can be learned (M. C. Zimmerman, 2002). She stated that “poor self-regulation skills limit learning and achievement in any environment, but while naive self-regulators may be able to complete face-to-face courses, it appears that naive self-regulation is more of a detriment in the online milieu.” If self-regulated learning processes are better understood in medical students,
then residential and online educational experiences can be structured to foster these skills. In medical education, institutions have focused on effective feedback, coaching, and modeling to focus on these self-regulated learning processes.

1.3 Project Description

Introduced in 2015, HMX Fundamentals was a series of e-learning modules, of which, physiology and immunology were the first subjects developed. There have been several iterations and expansion of the program since 2015; all results of this study and associated discussions are based on the 2015 version.

Within these subject areas, several lessons focusing on a range of sub-topics were developed. For physiology, these included partial pressures, movements of body fluids, flow through tubes, and compliance. The immunology course included overview of immunology and the immune system, innate immunity and inflammation, microbial recognition and response to innate immunity, antibodies (structure and function), and lymphocyte development and diversity. The physiology course had one professor and was heavily clinically-based with interactive animations, as well as videos of the professor making visits to patients in the hospital during which the principles and concepts being taught were applied to real-world clinical problems. The immunology course had fewer interactive components, real-life scenarios, clinical corollaries, and had two instructors.

The initial courses were offered to approximately 220 students from a variety of backgrounds and college majors who had been accepted into Harvard Medical and Dental School for Fall 2015. Within this group there was also a small group of health science and technology students (HST) who were involved in coursework both at Massachusetts Institute of Technology (MIT) and HMS, some with the goal of receiving a PhD with or without an MD. The offer to sign up for the course was introduced via email and in person, as a voluntary
opportunity, at a previously scheduled “re-visit” event prior to accepting a position in the class. The modules were intended to be delivered during the summer prior to the students starting in the fall. Students would interact with the platform and each other asynchronously, with one module per subject released per week. The course was communicated as optional and would in no way affect their scores or status with the school. The course ran from June 30 - July 21, 2015 followed by open access for the subsequent three months.

The modules started with objectives and a brief introduction to the concepts. For physiology, several of the modules began with a real-life scenario video or animation that served as a mystery without any upfront explanation as to what has transpired. Physiology had the most interactive components and will be described below using the partial pressures lesson as an example. Figures 2A and 2B show the diver mystery scenario at the beginning of the partial pressures lesson.

![Figure 2A](image1.png)

**Figure 2A.** Diver mystery scenario animation at the beginning of the partial pressures physiology lesson. It tells of a diver and her father going scuba diving. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.
Figure 2B. Diver mystery scenario animation at the beginning of the partial pressures physiology lesson. This shows the father surfacing without planned stops for decompression. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.

The mystery videos were followed by some probing questions and a repeat of the scenario with a narrated and, in some cases, animated explanation of the science behind the mystery video [Figure 3].
**Figure 3.** Replay of diver mystery scenario video with explanations of physiological changes. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.

Following the explanation, HMS faculty gave a short explanation video of the underlying principles. These were focused on using the mystery video as an introduction of the concepts and then using other analogies and physics principles to describe what was seen [Figure 4].

**Figure 4.** Explanation of partial pressures using a champagne bottle analogy employing “whiteboard” drawings and instructor narration. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.

A clinical application of the same principles was then presented [Figure 5] again followed by some probing questions. A summary and end of lesson question set were given. In some modules, an interactive animation was presented in which students could manipulate a virtual human and see, in real time, the changes in physiological parameters [Figure 6].
Figure 5. Instructor from the physiology module explains the application of partial pressures at the bedside with an actual patient and ventilator. Screenshot of HMX content obtained in 2015 with permission from HMX. Copyright © The President and Fellows of Harvard College.

Figure 6. Interactive diver animation which enables students to drag a virtual diver to different depths and see the associated changes in partial pressure in real time. Screenshot of
Once students completed the final course surveys, they were asked if they were willing to be contacted for interview. Those who indicated ‘yes’ were sent an email inviting them to schedule an interview. These students were then interviewed by the primary researcher between August and December 2015. The interviews were semi-structured and performed via Skype™ or Google™ Chat. The original plan was to interview 20 students, however, due to time and responses, only 17 students could be interviewed.

For all interviews, the audio was recorded, and in some instances the video as well, all with verbal consent from the students. The interviews were approximately 45 minutes to one hour in length. Students were told that the interviewer was a researcher who was a student in a master’s program through HMS and not employed by HMS or HMX and that they should feel freely to speak about their experiences. They were told that their answers would in no way effect their grades or status with the school. The interviews were then transcribed using a third-party service, which was funded by HMS/HMX. All interviews were coded by the primary researcher who performed the interviews.

Data were analyzed using content analysis. The process started with review of the data (transcripts) with open coding and memoing. Data reduction was undertaken with coding and codebook development based on the research questions. Coding was revised several times as informed by an inductive, iterative process of continuous literature review and thematic development. A final codebook was then developed (see appendix). Codes were synthesized into higher level categories and, eventually, overarching themes. The following was the result of that analysis.
1.4 Project Purpose

The purpose of the study was to study motivations and persistence in an e-learning experience for pre-medical students. This was designed as a pilot study targeted at understanding student motivations for initially engaging and completing an e-learning experience. The goal was also to briefly understand how certain design elements affect student learning and persistence.

1.5 Project Impact

This study contributes a qualitative analysis of motivation in online learning for medical students, albeit in a small, highly self-selective group. The study adds to the literature on intrinsic and extrinsic motivation, self-regulated learning, adult learning theory in online learning, and medical education. The design elements that were utilized in this study may help guide future development of online learning experiences as a stand-alone or as part of a flipped classroom model and contribute to further studies on motivation, online learning, and medical curricula.

1.6 Research Questions

1. What self-reported factors motivated pre-medical students to initially engage in an optional online fundamental learning experience prior to starting medical school?
2. What self-reported factors and design elements contributed to student persistence?

1.7 Limitations

This was a qualitative study; thus, no cause and effect can be established and there was no control group. Participants represent a small subset of all students exposed to the modules (17/220 or 7.8%) and were highly self-selected as they volunteered to participate in an interview, allowing for selection bias. Most participants who were interviewed completed the coursework (12/17 or 70.6%) and thus may have been more likely to have positive comments.
about their learning experiences. Harvard Medical Students, who were the participants of this study, are not a representative sample of the general population of medical students, let alone graduate students in general. The highly competitive nature of the HMS admissions process does select for certain personality styles, learning orientations, and levels of achievement. There is a tremendous amount of external pressures on these students for high achievement. Also, students in this cohort were part of a new curriculum and may be more open to innovative educational experiences. Due in part to all these factors, there is a general lack of generalizability to all medical students or health professions education. The participants were involved in a singular experience, as no other iterations of design were tested. As such, they only comment on what they have seen without being exposed to other designs. All interviews were conducted several weeks to months after the learning experience was completed and they had already begun the HMS curriculum. This form of self-reporting and recall affects their insight and reflection. They also were asked to comment about their initial motivations after the fact, which can be influenced by their overall orientation toward the experience and current attitudes with their curriculum. The interviewer did help with the HMX curriculum at its outset but was no longer involved at the time the research was conducted. Participants knew that the interviewer was involved with HMX, which may sway their responses, resulting from observer-expectancy bias. The interviewer was the sole coder which leads to a lack of an interrater reliability. There was a high risk of confirmation bias as the primary researcher was involved throughout the process and not blinded to whether the participants were completers or not. These limitations were attempted to be mitigated by openness about the researcher’s involvement with HMX and objectiveness during coding staying agnostic to their completion status until the analysis phase. Due to the lack of generalizability, the discussion is focused on this singular experience with this small subset of students.
Despite these limitations, the findings in this study still describe elements that led to improved student engagement and more autonomous motivations that may guide the design of future medical education online learning experiences.

1.8 Delimitations

Students were recruited voluntarily, as the HMX directors did not want to mandate interviews. Given there was one interviewer who was geographically removed, interviews were conducted via teleconferencing instead of in person. Due to lack of response and time allotted, only 17 of the 220 students were interviewed. No follow up interviews were conducted on subsequent iterations of design due to time and resources. The small subset of students who were dental or PhD students was included in the interview process, analysis, and discussion. No financial incentives were given to students, so as not to influence their responses. Observer-expectancy bias was attempted to be mitigated by the researcher stressing the lack of personal stake in HMX or its success.

A second version of the modules were made available to second and third year students at an international medical school. Interviews were then conducted, in English, with this cohort via Skype™ and Google Chat™. In total, twelve interviews were conducted and transcribed. These were not included in the analysis below due to several factors. These students were already enrolled in medical school coursework and the students only had access to one of the subjects depending on their year in school (i.e. second year students only received immunology and third year students only received physiology). They had only seen one or the other sets of modules and many had already received instruction in these same subjects in their medical school. Also, the students who were willing to be interviewed were self-selected based on their comfort in communicating in English. Those who were interviewed had varying abilities to communicate and some were especially superficial in their ability to communicate complex, deep seated beliefs and emotions. There was also a large cultural difference from these
students to those at HMS, leading to further complications in analysis and interpretation. Additionally, the versions of the platform were different, making comparisons problematic. Due to these reasons, the results, analysis, and discussion of this population has been excluded from this thesis work. However, research and analysis on this population may be undertaken in the future.

1.9 IRB

- This study was approved July 14, 2015 under: IRB14-3592: Foundational basic science learning with online modules.
- UTSW STU 092015-014 – Registration only.

1.10 Financial Support

This study received no funding, however, the transcription of the interviews was conducted by a third party and was funded through Harvard Medical School/HMX. The University of Texas – Southwestern Medical Center supplied partial tuition support for the primary researcher. The HMX platform is proprietary of Harvard Medical School.

2.0 Results

For the HMS cohort, 220 students were initially offered the coursework. Activation and persistence numbers are shown in Figure 7.
*Definition of persistence - For this initial course offering, students could not qualify for certificates and there were no final exams in the courses, so the statistic used for persistence was the final lesson of the course. These data were based on initiation of the assessment exercises, thus “starting” the course is defined as attempting at least one assessment in the course, and persisting to the last lesson is defined as attempting assessment in the final lesson of the course. This only covers the course period over the summer of 2015, however, these students retained access to the courses for several months afterwards.

2.1 Research Question 1

What self-reported factors motivated pre-medical students to initially engage in an optional online fundamental learning experience prior to starting medical school?

The Harvard Medical School (HMS) students who were interviewed named several different motivational factors in initially undertaking the online coursework. The codebook (see appendix) summarizes all the major codes, definitions, and corresponding quotations. Based on the content and thematic analysis of the codes several themes emerged and are discussed below. A major theme that emerged was extrinsic versus intrinsic motivation. The extrinsic motivations encompassed codes: sense of obligation, unpreparedness, peer fear, keeping
pace, awaken the mind, sneak peek, and background deficiency. On the spectrum of extrinsic motivations, there were varying degrees of internal versus external locus of causality, as discussed in the OIT (see above). The codes matched up to varying elements along the OIT continuum [Figure 1]. The intrinsic motivations encompassed codes: curiosity, interest in topic, pioneering, sneak peek, and opportunity. Of note, the code sneak peek had some elements of intrinsic and extrinsic motivations as some students were curious about online learning in the context of medical education or as a component of possible flipped classroom model. Some students made more statements about getting an idea of the scope of material or the fact that the coursework was tailored to them so that they have improved performance when medical school began.

2.1.1 Extrinsic Motivations (EM)

Students detailed an instrumental value to the coursework that motivated them to initially engage in the material. The instrumental value of the coursework was either to obtain rewards or avoid punishment/embarrassment. Quotations have been grouped based on the OIT continuum: external regulation, introjection, identification, or integration. Externally regulated student motivations were encompassed by students who stated they were doing the coursework due to obligation. There is no sense of value attached to the activity from an internal locus, and they engaged solely because they felt it was expected of them. Introjection is less externally regulated and has more ego involvement and a strong performance goal orientation. Student’s under this category often spoke about not wanting to be embarrassed in front of their peers. They often started the coursework to make sure they did not fall behind their peers. There was often a sense that future peers would be high achieving and the students were intimidated by this prospect. Identification is less externally regulated than introjection, and often the students ascribed value to the activity that in some way undertaking the coursework will benefit them. Integration is the most internally regulated of the extrinsic motivations and is characterized by
motivations seemingly emanating from within themselves. They aligned the coursework with their personal goals. Students in this category described entering a social contract with the institution by giving feedback on a new learning experience.

2.1.1.1 External Regulation

On the low end of autonomy exists an external locus of causality, termed external regulation. This form of extrinsic motivation has no ego involvement and is purely motivated by sufficing an external expectation, receiving an obvious reward, or avoiding a punishment. Some students stated that they felt obligated to do the coursework, even though it was voluntary, and the code sense of obligation was used in these cases. As will be shown, these statements infer a perception of an external locus of causality and these codes appeared to fall under the theme of extrinsic motivation, whether it be a perceived expectation from the institution or from the new normative environment of peers. These students were on the very low end of autonomy and engaged in the modules because they felt it was expected, either overtly, or implied. As this student stated:

I: When you initially got the email asking you to log on, what kind of things motivated you to actually log on and participate, let alone do all of it?

R: Part of it was definitely feeling like I didn't want to start behind… For me, when I'm asked to do something, I will do it, generally. I would much rather do it and feel prepared than risk being unprepared when I started. That's part of it for sure… I was under the impression, as I said, that this is something that was expected of us, and that we were asked to do. You don't really want to start med school behind.

Int 4, [00:23:26.75]
This student also described the undertone of a perceived obligation. There was a strong external locus of control and no internal valuing of the activity. This again was externally regulated extrinsic motivation.

*R: I don't really think I felt it was optional... And so I don't know. At this level, I feel like nothing at least in my mind-- and not everyone sees it this way and I appreciate that-- optional means you should do it.*

*Int 11, [00:27:06.61]*

The next two students discussed the perceived *sense of obligation*. Although these seemed strongly externally regulated, there is beginning to be a sense of desire to keep up with peers. These statements begin to approach more ego involvement that was characteristic of introjection, but remained as extrinsic motivations.

*R: I guess my motivation was that I didn't realize it was optional at the beginning. I thought it was a thing that everyone was doing. I'm not upset by that, but that was actually my initial [thought]. It was more like I need to do it, not like I wanted doing this.*

*Int 13, [00:25:29.74]*

*R: Even though it was voluntary, which I thought was great, it didn't feel voluntary for the most part. It felt like it was something that's "voluntary" in quotation marks, and that everyone would do it anyways or would ultimately have to do it to stay up to speed.*

*Int 7, [00:22:15.56]*
The strong sense of extrinsic motivation was seen in this quote with the lack of interest in subject matter and the external locus of causality. The student finished by establishing some sense of aligning values.

I: You said it was something about the subject areas that drew you in.

R: Immunology was pure necessity…That was it. I had no-- like very little interest in it. Although, I did some work that sort of barely touched immunology. I sort of liked that one little corner out in left field of immunology, but the rest was just like, I'm going to do this because it will help me.

Int 12, [00:25:12.52]

2.1.1.2 Introjection

Introjection is a more nuanced sense of ego involvement that is focused on the approval of others, whether it be an institution or peers (Ryan & Deci, 2000). Introjection was characterized in these students by this ego involvement and a strong sense of performance goal orientation. These students undertook the course to improve their performance in their future classes, especially as compared to their HMS peers. Several students stated an overall feeling of being unprepared for medical school. The code unpreparedness was used in these instances. When it was a fear that their future peers would be more prepared, or higher achieving than them, the code peer fear was used. Introjection deals with comparison of yourself against peers and the perceived threat of their peers was a strong motivating factor for many students. This sense of threat/fear seemed to be compounded by a lack of self-efficacy or self-confidence in either of the subject matters. Lack of exposure to pre-medical coursework, or the specific subjects offered, contributed to this lack of self-confidence. Thus, a major theme was a sense that doing the modules was either to offset a perceived background deficiency or
to *keep pace* with their peers. There was also a general sense of fear from the rigors of future curriculum itself and some students saw this online curriculum as getting an advanced look at their upcoming residential courses. This student described a perceived feeling of external pressure from peers that was compounded by a professed weaker background. This was typical of the extrinsic motivations of introjection.

*R*: So there was a little bit of that pressure to get this done. And if I don't do this, and everyone else gets this done, then I'm-- again, with my background, I already felt a little bit behind. If I came in without some of this knowledge, I feel like I might struggle even more

(Int. 1, 00:33.29)

This same student went on to elaborate on their previous statement. Some may consider this identification, but again the focus was on performance compared to peers as opposed to pure valuing within one's self.

*I*: So you said that even though it was voluntary, you felt that it was more required, I guess, in some sense?

*R*: No, not required. Definitely voluntary. But required, perhaps, by peer pressure, but not required by anyone in the program, obviously. But if I had just come from working in an immunology lab for three years, maybe I wouldn't have felt that it was required. Maybe I would have gone through and seen, oh, this is what they're talking about. I know this. I'm not worried about this. But again, for someone without the biology background, without the strong medical background, it felt more required for me, trying to get everyone up to speed.

(Int. 1, 00:34:02)
These next two students again described the fear of being unprepared and being compared to peers who are perceived as high achievers. This new normative environment changed the assessment phase of their self-regulated learning processes and motivated them to do the coursework to keep pace, or catch up, with their peers.

_I kind of felt that the majority, if not all, of my classmates, were going to be doing it._

_And that if I didn't do it I'd be behind._

_Int 11, [00:27:06.61]

_I: HMX said maybe you should check this out. What kinds of things are going through your head when you're deciding whether to participate in something like that?_

_R: I think, to be honest, I felt so unprepared coming to a medical school. But if they had said, go to this YouTube channel, and subscribe and watch the 25 videos on there, I think personally I would have done it. Yeah. I think that's just probably the fact of it. But I do think I was more motivated. I would have done it either way._

_Int 6, [00:36:35.79]

_Students were asked what the effect that the modules were a product of HMS as opposed to another high-level institution. This student’s motivations are considered introjection as the focus was on the instrumental value of material on performance in future assessments._

_I: Lets say this was a product put out by Stanford and HMS say maybe you should check out Stanford’s. Would that have changed anything for you?_

_R: In terms of preparing for an HMS exam, I may look at it, because that is something that I have done in the past in undergrad, but there would still be that
uneasiness of thinking about whether—because at the end of the day we still need to pass our exams. And if Stanford is missing something that is going to be covered on HMS exams, there is still that uneasiness about that. So you would look at it but there wouldn’t be that feeling of complete understanding in terms of preparing for an assessment. If this was a general resource in regards to step one, I would have no problem using it…But if I am preparing for HMS assessment there would be that uneasiness about using it…The most important thing is that we get the information, but, at the end of the day, you can understand it but if you don’t perform well on the assessment, that will cause you problems down the road.

Int 18, [00:30:06]

This student when asked about HMS, discussed being prepared compared to their future peers. There is a sense of fear or perceived threat and again a performance goal orientation. Again, this was a strong extrinsic motivation as they discussed the instrumental value of the material.

I: How about the effect of the school? The fact that it was going to be your school putting this on, as opposed to let’s say, Stanford, or Georgia Tech, or something.

R: Yeah. So I guess in that respect, I would say it goes more back to feeling prepared and also— which I guess prepared is having the information, but then passing that threshold. And so I felt if my classmates were all going to be doing this because it’s offered through my school, then there’s a certain threshold that they’re going to be past and depending on if I have this information or not, I may not be. And so not that being prepared is necessarily relative. But if everyone comes in knowing something and you don’t, then I feel like that’s when you feel unprepared, whereas if everyone comes in not knowing something. I don’t feel like we all say
we’re unprepared, because oftentimes it will become-- that’s the level people will start at because if they didn’t then no one would learn anything. So I think in the way it is kind of that relative, I want to be at this threshold or above it. And if my school is telling me this is stuff that I should probably know or would be good for me to do over the summer, then I mean yeah. If I found out about a similar course from another school I probably wouldn’t do it. Because I wouldn't think my classmates were also all going to be doing this. So we weren't going-- I wasn't going to be being at a lower level on the coming in.

I: So it was the fact that because it was your institution that your peers would be taking it. As opposed to the fact that it was HMS itself.

R: Exactly… My school is suggesting to me that I do this. And they’ve sent this email to all of my classmates who are also probably going to do this. I guess a part of me would want the school to do it themselves. But at the same time, you know everyone’s time is limited. So if it was someone else putting it out there and again, Stanford’s a very, very respectable institution. So I would think the quality I was getting from Stanford would be just as good. So it wouldn't be something that I would expect that Harvard would have, something that they were doing maybe not this time around but-- I don’t think everyone has to do things over and over again, the same things. Because then it's just-- people’s time can be better spent in other ways. But it was nice to have it in-house. But I would still have done it whether it was another institution or other great professors for the reasons that I’ve told you.

Int 11, [00:35:10.05]

A sense of peer pressure was a common sentiment and the code peer fear was coded in 10 out of the 17 interviews. This student explained that peer fear is a sense of intimidation from
a new normative environment and perceived academic prowess of future classmates. This again demonstrates the introjection category of extrinsic motivation as the student has a strong performance goal orientation to their statements.

*R:* I was kind of a little bit upset that I had to do-- I mean, I didn’t have to, it was optional, but I felt held to do this work.

*I:* tell me a little bit more about that feeling…tell me more about feeling compelled.

*R:* I guess when I’m getting into this medical school and so when I got in and I decided to go, I felt intimidated. I thought the other students would be at a higher level and I would really need to do everything I could to just be able to keep up. So I really felt like I should do this to—

*I:* And I guess the intimidation, [was it] a general feeling of intimidation? Or is it, like, intimidation for certain subject matters?

*R:* I think it was a general feeling of intimidation. And I also thought that the quality of the incoming students would be so high that-- and everyone would be so kind of on top of things that everyone would do this, and if I didn’t, I would be the odd one out and I might be put at a disadvantaged when classes start. I didn’t want to already be behind in classes.

(Int 2, 00:19:29.05)

This student discussed the compounding factors of low self-confidence and background in these subject areas as well as the peer intimidation as the primary motivators of initially engaging in the material.

*R:* I said, I had no background and really no background in anything we’re talking about all. Very sort of basic biochem can and basic genetics. And that was really it.
So, I felt like having me a lot of my future classmates, some of them had PhDs and biochemistry and things like that. I probably needed to do some kind of—something to catch up. And it was. Yes. I think the motivation was there to do whatever I could to be prepared, to show up ready to go.

Int 6, [00:19:58.52]

This next student initially described introjection and performance goal orientation when discussing their motivations.

I: What would you say was your biggest motivator for actually doing it? Was it something particular in your background, or that, like you said, the fact that everybody else was going to take it, or what was it specifically that made you want to do the material?

R: I think one was kind of, as I mentioned, I thought everyone would probably be doing it, so I should as well. But also as I mentioned, I didn't want to start off med school behind already, or without having put in the time necessary for all these different modules. So I thought that for me, it would just help me brush up on these different concepts. And it kind of was reinforcing my commitment to put in the time to med school and start easy over the summer. Int 7, [00:22:59.16]

2.1.1.3 Identification

Identification has more autonomy than introjection in the sense that students identified that doing the activity self-aligned with their own values, but they stopped short of integration, which is defined by a sense that the motivation emanates from within. These next three students stated a general sense that they recognized that engaging in the activity was a valuable experience.
R: I don't have the best background in immunology. And coming to med school, I thought it would be good to kind of get a refresher, start learning a little bit more about that so that when immunology courses do come around, it won't be as much of a shock. Int 5, [00:14:40.06]

R: I found out that it wasn’t required the same time I got the email.

I: Oh, OK. And so what made you still do it?

R: Because I knew I was weak in the subject.

I: OK. In those particular subjects?

R: Yes.

I: OK. Excellent. So any other motivations, any other reasons why you decided to look at the videos, or was it pure that you were uncomfortable with your background.

R: No. It was more just uncomfortable with my background.

Int 3 [00:31:42.01]

R: I was like, I can't be behind before we start. I'm sure at some point it could be a good thing that I did that.

Int 4, [00:11:14.00]

Under self-regulated learning, there is a planning phase that involves goal setting and self-efficacy as well as motivation. A general sense of lack of self-confidence in this material
seemed evident that led to a sense of wanting and needing to learn this material to fill that gap. Under the same code of *background deficiency*, there was an increased element of internal locus of causality in their extrinsic motivation. This was well stated by this student.

*I:* So you think it was definitely something about your personal strength in those subject areas that was more of a motivation for you to go through the coursework?

*R:* I'd say that was probably one of the stronger motivating factors, yes, my personal background and wanting and needing to learn these things. Yeah. I'd say so. I did, I found it very interesting, especially the physiology, because I hadn't ever had that before, and because my background was a lot weaker, it was interesting to see these things in action.

*Int 1, [00:34:53]*

This sense of want and need was interpreted as a conscious valuing of the activity, placing this student under the identification type of extrinsic motivation based on the OIT. However, this did not qualify for integration or intrinsic motivation, as these students still had some element of external regulation as opposed to deriving enjoyment from the task itself.

*I:* What was the motivating factor for you to actually sign into immunology? What made you want to do it?

*R:* I think partly feeling like this is a good thing to do, like this is the version of me as a student that has better study habits would be engaging with the material earlier and more often than I historically have done. So that, plus being pretty curious about what level of detail is med school going to be operating in?

*I:* So you sort of saw it as a reflection of what you’re going to be doing, essentially.

*R:* Or some insight to it, yeah.
Students were asked to describe the extent to which the courses, as products of Harvard Medical School, affected their motivations to engage in the material. Many students stated that it was a motivating factor because they assumed that the scope of the material defined what was needed to begin residential coursework. Some also stated the fact that they were under the impression that the online modules were going to be the basis of their future flipped classroom model under Pathways. This is likely considered identification due the aligning of the value of understanding the scope of future material with doing the coursework and was coded sneak peek. These are extrinsic motivations that value the activity due to the instrumental value of the preview as giving them an advanced look at their future curriculum.

I: What was the effect that it was going to be your professors that’s actually going to be teaching the course on your wanting to sign in and do the coursework? Did it have any effect?

R: Yeah, I’d say an effect. It certainly wasn’t the main one, but the fact that, if they had just said, here, watch these videos on YouTube from some guy somewhere, then I probably maybe would have done it. But it’s not the same as, this is the individual who’s actually going to teaching you, so you’re not going to be learning superfluous things. You’re not going to be learning things that he doesn’t want you to know specifically. And so that motivated me.

R: I felt like it was a really good way to kind of get introduced into what we were going to be doing in our curriculum, while also learning a lot... I also was curious to see what it was like. I was curious to see if this is going to be like what class is like.
What is it, exactly? And what is the curriculum going to be like when I start? That was definitely a really appealing aspect of doing it.

Int 4, [00:06:15.27]

Some students simply stated the fact that since it was HMS, it was more motivating because there was an expectation of high quality instruction. Some went on to say that had HMS suggested other materials from other elite institutions that the students would have attempted the material. This was coded as high ROI and high predicted ROI and was best stated by this student who said:

I: What was the effect of the fact that this was two of your, potentially, professors--obviously I know you may not get [instructor’s name] but what was that effect on your willingness to participate?

R: Well I guess again, I wasn’t really sure I was going to have either of them. So for me, it wasn’t a huge factor. I guess it was neat to be instructed by Harvard professors, who may or may not have been-- were going to be my professors. Because I respect them. And I thought the quality of the material that was going to be presented was going to be very high. And so I think, in that respect, thinking that what I was going to receive was high quality information. And I think that was certainly encouraging. But again, because I didn’t think that either of them were actually going to my professors, that wasn’t a big part of my decision.

Int 11, [00:31:38.37]

This student stated similarly the sense of the coursework being tailored to their curriculum and the instrumental value of participating.
R: I think the fact that HMS was doing it-- I knew it had been tailored for our curriculum. The effort that had gone in from professors that I knew we were going to interact with down the road made me much more, I guess, maybe want to participate much, much more greatly than if we had just been given a link to Stanford's equivalent to HMS.

Int 7, [00:27:51.00]

This student even stated a feeling of relatedness to their school through experiencing HMX. As was discussed previously, a sense of relatedness and community increases engagement (Reich, 2014).

I: How about the fact that HMS was the one that put this out, that it was going to be your school, as opposed to, let's say, Stanford, or Georgia Tech, or somebody else who put this material up?

R: Yeah, oh, definitely. I think that was a huge deciding factor. I was just impressed with the school and motivated to do it, because I felt like a part of the community putting it out.

I: Right. And, again, is it a quality issue, or is it, again, the fact that this is your school? Besides the fact that it's Harvard.

R: I guess mostly the fact that it is Harvard. Like, I'm sure Stanford would put out an amazing video series, as well, but I wouldn't necessarily feel as compelled or obligated to take part in it...One, I think, also, because I realized that you guys were looking for feedback. And you want feedback from HMS students so that was also another reason.

Int 13, [00:34:37.08]
Importantly many of the students interviewed stated that had HMS not offered this opportunity, or if it had been a selection of readings instead of an online course, they would not have done the material. This underlined the need for an external pressure to address perceived deficiencies and the overarching extrinsic motivations of these students.

R: I imagine that if it had been oh, by the way, in case you want to do this prep work, Stanford has these videos. Take a look at them. If that had been it, I probably wouldn’t have done it. But since it was this is some HMS stuff, kind of like what you’re going to be doing, very relevant to what you’re going to be doing, then yes.

Int 4, [00:21:29.30]

**2.1.1.4 Integration**

Integration is a conscious sense of the activity emanating from an internal locus of causality. Essentially, the instrumental value of the task is completely aligned and congruent with the sense of personal value placed on it (Ryan & Deci, 2000). It is still considered extrinsic, because the value of the activity is external to the enjoyment or interest in the task itself. One such code was *pioneering*. This student gives a sense of that engaging in the modules was a sense of social contract with the institution and being supportive of their endeavors.

I: What was the effect that the instructors were going to be your instructors on your motivation to participate?

R: I think it was a positive motivation. I had heard about some of these people before. I’ve had some friends that have been there a while. I talk about in particular like [instructor’s name] what a great teacher he was and how engaging he was and what a great guy he was, and all that stuff…I think it’s part of being in this branded curriculum, you want to be supportive and try whatever the new thing is and give
honest feedback. So I think, yeah. I think that it was a motivation to put your best foot forward and try things. Int 6, [00:32:57.54]

Some students felt like they were participating in a rewarding opportunity to see something new and wanted to provide feedback to the school. This was also coded as pioneering. This may not be surprising since these same students were the first to experience the new HMS curriculum. Some communicated a sense of obligation due to the perceived effort that the school and faculty had put into the modules. This was coded as institutional effort. This student described the pioneering aspect.

R: I think in some of the anatomy stuff we’ve seen not in HMX but in our current courses, it’s brand new. And we’ve looked at other materials from other schools that are very no name that I think are better. So I don’t think that it was like a Harvard thing that made me want to do it. I think again, part of being a good learner or a good citizen-- kind of a cliché phrase-- part of putting out your best effort as giving a shot and giving honest feedback on a product that they’re clearly very adamant about improving I think that was a motivation. So hopefully next year they’ll have HMX 2.0 or whatever and it’s more engaging and better. I think one of my improvement comments for the entire thing is I think they could include a lot more material. And I think there would be people that would be motivated about be doing a lot more.

Int 6, [00:34:27.32]

This student described more of the social contract perception.

I: How about the fact that it was online through videos, as opposed to, let’s say, they handed you a handbook or a PDF of all the material. What was the effect that it was online?
R: I think it made me think that it was, like, a bigger deal for the school, because I know that-- well, I don't know, but I imagine that it takes a lot of resources to put together a really good instructional video. So almost just wanting to me HMX halfway-- kind of thing. And they also showed a level of effort from your end. I mean, I had never really learned through videos before so interested in seeing what that was like.

Int 13, [00:37:28.64]

Some students stated a general sense of activating their minds after several months to years off from schoolwork. This was coded as awaken the mind and was considered integration on the OIT continuum. They still used the modules as an instrument extrinsic to the activity itself. As this student described:

I: Take me from your first impressions, when you first got the email from the HMX Fundamentals, to you actually logging in and actually taking the course. what was going through your mind? Feelings, attitudes, things like that.

R: Oh, I was very excited. It was a great opportunity to get things going a little bit early, just get the ball rolling, get the juices flowing, and get me thinking about things.

Int 1, [00:32:57.35]

Another student echoed this sentiment.

I: What was your first impression when you got the email from HMS about signing up for-- or logging on to HMX? What was your first impressions?

R: I was expecting it. I'd gone to revisit. And they had talked about-- look for this email. And I looked forward to it. I like to try to go and do in the experience as
prepared as I can. And I thought it would be a great way to start thinking about-- so it was optional. So I knew I wouldn't be like mandatory [INAUDIBLE], but I thought it would be a good way to kind of transition from doing nothing over the summer mode to kind of thinking about things that are relevant. Yeah. So I was looking forward to going through it.

Int 6, [00:18:16.74]

This next student described their desire to initially engage in the modules as a combination of a weaker background and to maintain some work ethic. This student then showed some elements of an increased internal locus of causality.

I: So ultimately, what made you decide that you did want to do it? Since it was voluntary.

R: I think largely, my perception of having a lower background in biological science than most people. And also sort of as a way to maintain a little bit of work ethic during the summer. Because I was-- I mean traveling Europe was really fun, but it was definitely not work ethic. And then I think my coming home. I have all these other things pulling for my time and I think it's just nice to sit down and learn something every once and a while, anyway. And it's something that'd be useful to me.

Int 12, [00:25:12.52]

This student again shows more an internal locus of causality showing interest and excitement. They still used the modules as an instrument extrinsic to the activity itself and was considered as extrinsic motivation.
I: When you got the e-mail, what was the motivating factor for you actually signing on and checking it out? What were you thinking when you were doing that?

R: Well, I think I was kind of excited to start grad school, and so it was like, here's the first piece of my PhD program or something. I just wanted to see what kind of stuff I would be learning. And it'd been like a while since I'd taken any classes. So it was like now I get to study and learn a cool thing—medical stuff related. I think it was mostly like I was excited to start grad school and the topics seemed interesting.

Int 15, [00:36:37.93]

2.1.2 Intrinsic Motivations (IM)

Not all students were extrinsically motivated. Several students stated that they had a genuine curiosity and excitement for engaging in the coursework. The intrinsic motivations encompassed codes: curiosity, interest in topic, pioneering, sneak peek, and opportunity. As this student described a general curiosity about online learning in medical education.

I: What was your kind of first impression when you got the email from HMX telling you about this program?

R: I was excited to try it out mostly from a curiosity perspective to see what HMX is trying to do with online constant. And in general, I've been trying out different online content websites just to see an idea of the world, especially since I'll be in academia for the rest of my life...So I'll probably be interacting with one of these platforms at some point...I was curious how you would structure a medical course as an online course, especially since there are certain parts in medicine where I thought like, you know, histology and things where when I did pathology at HMS, I really appreciated the hands-on things I did. And I was curious to see how such
things could be in a course that's online, so I wanted to see, what would they focus on? And what are the gaps that you would not glean from an online medical course?

Int 10, [00:32:03.21]

This student communicated that regardless of their extensive background in immunology, they still chose to go through the material. As they stated:

I: What was the effect of the material, the subject matter? The fact that it was physiology and immunology, was that a deterrent, or was that a motivator, or neither?

R: It was a motivator. They're both subjects that I enjoy. And even though I've seen a lot of the stuff in immunology before, I guess it just goes to show how much I love the topic. I can slog through it over and over.

Int 9, [00:01:19.36]

This student had an extensive background in physiology and still wanted to participate due to the novelty of the platform and genuine curiosity. As they stated:

I: What was the motivation to actually doing it was it anything particular in your background are you know what..what was it actually made you kinda go for it?

R: Because the way they introduced when we were here at revisit they said that they were, basically, going to be introducing a new system. And for me, anything that is new is cool, I like the whole innovation stuff and part of the excitement was that I was under the impression, like I said, that that was going to be a new method of class delivery and I was curious. And the summer before med school you are just very curious of how things are actually going to be. I was really curious as to
what classes may look like while I’m here…I did it because I was kinda curious to see how it would go.

Int 18, [00:24:50]

2.2 Research Question 2

**What self-reported factors and design elements contributed to student persistence in the optional online coursework?**

Students stated various factors that led them to persist with the material. Many stated a general enjoyment and fun in going through the modules while others stated the intentional design factors including interactive components, animations, videos, and patient encounters were engaging and enjoyable. Most students who specifically mentioned specific design elements, were referring to the physiology module, as more clinical correlations and bedside visits were integrated into these modules. Many students specifically mentioned the introductory mystery videos and interactive diver animations in the first lesson of the physiology module [Figures 2-3, and 6, respectively]. Although, many students stated from a programmatic level they enjoyed these design factors, some went to the point of stating that these motivated them to keep persisting through the material. Some students stated enjoying exposure to actual patients. They enjoyed the patient interviews and encounters and saw them as their first patient experiences. This was coded as *early clinician*. This student described the emotional effect of seeing patients in the online physiology modules.

*R: I loved the clinical aspect, like, seeing patients and things like that. I think for, like, especially someone going to medical school, I consider those almost some of my first patient interactions. And it definitely like, struck me, like, seeing one patient, like, struggling to breathe. And, like, the treatments, like, I actually felt like I had almost, like, an emotional response to that so that was really positive.
I: OK, excellent.

R: So I would advocate or vote for keeping that. I don't remember if the immunology one had any clinical applications, but I think any, like, additional clinical qualifications, I think, can only make it better.

Int 13, [00:51:12.65]

Another student echoed these sentiments and stated that the fact that it was HMS instilled a sense of connectedness to the material. A sense of connectedness and relatedness are elements that have been shown previously to intrinsically motivate students (Niemiec & Ryan, 2009; Reich, 2014).

I: What was the effect that this was going to be your professors teaching this course, as opposed to somebody else's professors?

R: Oh, I thought that made a huge difference. When I saw [instructor’s name] in person, it was like seeing a celebrity...I felt a greater connection to the material. I knew that-- I was amazed at how much time the instructors have put in to developing this content, finding the patients to interview and all of that. So I had a lot of appreciation for the time that went into these modules. And it made me want to take advantage of it more, given that I knew it was tailored by my professors. It was really meant for us to go into our curriculum. So I thought that really helped...I think the fact that HMS was doing it-- I knew it had been tailored for our curriculum. The effort that had gone in from professors that I knew we were going to interact with down the road made me much more, I guess, maybe want to participate much, much more greatly than if we had just been given a link to Stanford's equivalent to HMS.
Int 7, [00:26:55.59]

This student described how the cases and patient stories allowed them to obtain a deeper understanding and retain the concepts that were presented. The feeling of competence has also been linked to promoting intrinsic motivation and learning outcomes (Niemiec & Ryan, 2009; Ten Cate et al., 2011; White et al., 2014). Importantly, through these examples, there is a transition to more intrinsic motivations as they went through the material.

I: What kinds of things were most memorable from our platform? Either because they were really good or they were really bad.

R: Yeah. I just really enjoyed the physiology format. Going through some specific case and then being able to remember that case. I mean I can still-- you know the pastrami sandwich, the diver, the kidney, visiting the patient in ICU. Seeing the percent the oxygen and then knowing why it has to be higher than hemispheric. I just thought that it helps solidify concepts that have those specific examples and then explain the processes underlying the macro effects that we see.

Int 12, [00:35:37.10]

This student explained that although the clinical videos did not contain novel information, they still felt a connection. They saw the proximal application of the material they were learning. Proximal application of material aligns with Knowles et al concept of the need to know and the orientation to learning. When students see why they are learning material, they tend to be more intrinsically motivated. This design element facilitated the transition from extrinsic to intrinsic motivations. As this student explained:

R: I really like the clinical consideration videos. I don't necessarily think I got a ton out of it in terms of the science content, but it was a good add on and it was
something that I was like, I definitely want to watch these. And I'm trying to think of other-- the animations were I thought pretty good in terms of the immunology videos and the different pictures of the cells.

I: And you said specifically that you don't feel like you got much from the science content. Do you think, was it because of the level of the discussion, how fast it was discussed, or you didn't see the leap from the basic to the more applied? Or, what was it?

R: So yeah. Specifically from the clinical videos, I feel like I didn't get any additional science content than compared to the rest of the videos because I think they were-- they definitely emphasized the same basic contents that we had been over earlier in the other videos. Yeah. Even despite that, I still wanted to watch them. I'm trying to think. I guess there were some-- like you know, this is an extra. This is how it is applied in the clinical context. But it wasn't something that I couldn't have learned just by like reading, oh, this is how we apply it. But I like the clinical videos just for actual seeing a patient and actually getting to hear how it affects their life, et cetera, et cetera.

I: And do you think that having those clinical considerations kind of increased your curiosity for how it is applied in the clinical setting?

R: Definitely. Yeah. It was cool to see these basic concepts applied because I feel like a lot of what you learn in these sorts of things you're like oh, I'm never going to remember this. I'm never going to need this. But actually having a video of them using this in the clinic was definitely a make it stick.
The code *media effect* was used when students noted how the interactive components and animations affected their learning. Again, the Knowles concept of orientation to learning was discussed as the clinical scenarios motivated them to persist.

*R:* It can be complicated, but they did a really good job of balancing the videos, and also with the kind of modules. I'm trying to think of what-- the memorable one is the scuba diver. I don't remember what the right term is, but a scuba diver.

*I:* Scenario.

*R:* So that was definitely a memorable one. And I think it was great to have it relate. I really liked how they related it to clinical aspects of medicine, and feeling like I actually care about what's happening to this scuba diver, because it's something that I might actually have to treat, instead of just having it be-- on our premed curriculum it was like, learn about partial pressures. Why do I care? And now it feels like they did a great with making it seem relevant.

*Int 4, [00:06:57.23]*

This student went on to talk about how the contextualization motivated them.

*I:* So I've really enjoyed clinical application stuff we've had in our materials I found really interesting and engaging more so that just kind of here's seven proteins that interact in a cascade and do whatever and you don't really know why. Having some context and not kind of learning things in a vacuum has been really motivational. But I mean, at this point everything is so new that it's just exciting to be studying things that I want to study.

*Int 6, [00:06:25.47]*
This same student went on to describe how the interactive elements improved their understanding. The ability to experiment on a learning experience aligns with the concept of adult learning theory and the Kolb’s Learning Cycle. Kolb’s discusses the cycle from a concrete learning experience, to reflection, to abstract conceptualization, to active experimentation (Armstrong & Parsa-Parsi, 2005).

R: I think the scuba diver situation interactive scenario really stuck with me as one of the high points of the course. I thought the ability to kind of drag around the diver depth-wise and watch different values change and things, I think that really helped, just kind of messing with it and playing around with it helped me, help reinforce some ideas that I probably knew talking about, partial pressures and things like that, again, like Gen Chem in college and whatever that was, like 2005. But yeah. I think that my understanding of that even ties in with-- like I’m a certified diver. Like I probably should understand some of these things better. But yeah. I think it did reinforce like, what does it mean to have the partial pressure of oxygen change as you dive verses just total atmosphere pressure versus gauge pressure, all those things. I think especially in that kind of interactive module I think really were helpful.

Int 6, [00:25:17.15]

These design elements were again echoed by this student, who stated:

R: I loved it. I really, really liked the interface. I thought the first module, which I think was a scuba diver module, was just so well done. And I was just kind of wowed by the effort that had been put into designing it. Because I thought it was very clear. The example videos were clear. The instructional videos were short enough so that I was willing to sit through it. But it was concise. And for me, when I learn, I need concrete examples. And one of the things that I’ve often found in the
basic sciences is I can't see it, I can't visualize, I can't connect with what's going on in the cells to really be able to understand what's happening, versus physically being able to picture or just picture it in my head. So the scuba diver example, I loved that. In physiology, there was another example, I think, with the cork and the champagne model, which I thought, again, was just a really neat way to illustrate the concept. Because everyone can visualize that or relate to that and know what's going on. So I just thought that the interface was great. And I really enjoyed the course.

Int 7, [00:19:06.28]

As an unintentional design element, immunology had fewer real-life experiences, interactive components, and patient interactions. This led to an unintentional form of A/B testing of the two modules. This student described the differences in how it affected their motivation.

R: And then immunology-- so then I did immunology. And I did not find it as user friendly. I guess the interface was fine, exactly the same. But I thought that it was much more of a dry lecture course that you were just watching. It was confusing. I thought it was much more confusing than physiology. I thought there weren't--maybe it's harder. But there weren't as many examples or cool clinical correlations, whereas in the physiology I know there were visits to the pulmonary function lab. And then in immunology, I can't remember. But I don't remember seeing some sort of direct patient interaction or clinical correlation, which is something I'm always looking for.

Int 7, [00:20:38.71]

This student also described how certain design elements were lacking in the immunology modules.
R: So I do think that, if had been really bad, maybe I wouldn't have, but I felt like at least physiology is particularly-- I really enjoyed the material, and felt like it was relevant, and felt like I was learning a lot. I think immunology, as I said, was a little bit harder to understand, so I was less excited about doing it. I still did it and was fine with it, but the quality definitely helps. Int 4, [00:23:26.75]

This student also discussed the differences between the modules.

I: You said, you probably feel that your immunology knowledge was a big motivating factor. How much your physiology knowledge? You felt that you're relatively confident in your physiology, yet you still ended up going through that course work. So what was it about the physiology course work?

R: I actually enjoyed that one much more. Because that one showed me how these topics are being applied in real life. And so I think these scenarios were really nice. Because I didn't feel like I was just learning concepts and using equations, I could kind of see how the equations were relevant and used to understand the bends and people with different breathing issues and that sort of thing. So again, I guess it wasn't necessarily the information, in that case, that I was super keen on going after. It was the exposure to the clinical side of the information that I thought I knew a little bit already.

Int 11, [00:28:59.91]

This same student continued to explain that the orientation to learning and the clinical scenarios motivated them to persist. The transition to a more intrinsic type of motivation is apparent.
R: I personally felt the physiology course was done much better than the immunology course just because I would have liked to have seen more applications to the clinic. Because at least for me-- I don’t want to speak for others-- but I think a lot of us are here because we want to make these connections between the science and people and helping people. And so especially coming into medical school, to have one of these summer courses already be bringing me into the hospital. I thought that was really neat. The immunology course felt more like a course I’ve already-- not that I’ve taking immunology-- but like my other courses that I have taken where you don’t really make that connection. And I think that’s something I’m very excited about being in medical school is to have patients come to the classroom and to hear from them what it’s like to live with different diseases. And how what I am learning could help them. I think that’s certainly something that is very important to me.

Int 11, [00:43:34.13]

Several students claimed that the perceived institutional effort not only influenced them to initially engage in the material but to also to persist through the material. When interviewees were asked in general about classroom and professor motivations prior to medical school, they often commented on a sense of caring and passion from the instructor as it related to both the students and the subject matter. As this student stated, they felt that in an online environment that sense of passion and caring was manifested by the quality of the material and the effort put forth by the institution.

R: The material was very good quality. There was no doubt about that. The videos were wonderful. The bit of written material that there was fine. I think it was a very good quality. If it had been sort of slap dash, I don’t think I would have stuck with it. If you’re not going to bother putting time into it, then I’m not going to bother putting
time into it. But yeah. I thought it helped. I thought it was quite nice. Int 1, [00:42:35.14]

This was echoed by this student who stated:

I: [So you stated] the feeling that it was very high quality, was it anything in particular that made you think it was high quality?

R: yeah. I guess, I don't know, I guess there's a degree of professionalism in it that played into that. [INAUDIBLE] in the videos they were all, at least [instructor]'s videos, they were all consistent where he was standing up wearing professional clothing and the white background, looking directly at the camera and explaining as if you were in the same room with him. And that was consistent throughout all the videos. The videos I'm used to seeing are someone, like, with a home recording device, like, in a cluttered office kind of with their feet propped up explaining something off the top of their head. And it seemed like this was very well planned. And it was just very, very professional. They kind of elevated it in my head, I think, and it made me more compelled to be a part of it, to buy into it, to pay attention.

Int 2, [00:22:36.56]

This student discussed how the quality of the videos made the coursework more enjoyable.

R: I did like was the quality of the videos. I thought that was, like, really impressive, and it made me want to watch the rest of them so that was good. Int 13, [00:43:52.25]

This student describes how they enjoyed the ability to go at one’s own pace and the ability to pause. This was also discussed by several other students. This seems lead to a feeling of autonomy so that students can pick and choose what they watch.
I: What was your first impressions of that kind of learning platform before you had done anything previously?

R: I think it was very positive. I think it's a great way to teach people things. I think the ability to go at your own pace is great, being able to pause it. And I think also the forethought and preparation with which you have to use to plan a video. Instead of an in-class session, you can-- I guess with a video, you feel-- at least I would imagine, making a video, I would feel like I needed to do a little bit more planning and I have it better mapped out than if I'm in class. It's a little bit easier to go with the flow.

Int 4, [00:04:03.28]

This student discussed explicitly the transition from more of an externally regulated mindset to one of a more autonomous mindset.

I: What about the fact that it was voluntary? Did that either motivate you, demotivate you-- had no effect?

R: If you hadn't asked me, I probably wouldn't have noticed. But in retrospect, the fact that it was voluntary probably did motivate me. I feel like 99% of the time when universities have those online inventory module things, they are usually just [expletive], and people are going to click through them and not learn anything…See, I felt like, again, I feel more motivated to learn when it seems clear that I'm doing it for my own benefit rather than to just fulfill a requirement. I don't know if it's a requirement that I necessarily value, I guess. I don't know. And also because I'm a little bit-- on the one hand, philosophically, I like the idea of online education things. On the other hand, I feel like most of the time the way they are put together-- it's garbage. And so this seemed like it was actually put together,
and the content was good, but I feel like usually if my school had told me, take this online course, [INAUDIBLE] I would have been like, this is probably stupid and a waste of my time. But it’s like when I checked it out, it seemed kind of put together, and because it was voluntary, I think it made me a little bit more amenable to it I guess. Int 15, [00:42:31.34]

This student, who was a non-completer, stated that peer fear initially led them to sign on but later competing interests and technical difficulties with the platform outweighed the peer fear when it came to persisting through the material.

R: It didn’t seem to me like I would have to do it, but I felt like I-- it kind of was a little bit stressful because I was like, oh, maybe everybody is going to do it. Maybe I should do it. But I knew that I probably didn’t have to do it.

I: And can you tell me a little bit more about the statement you just made?

R: Oh, the stressed out part? Or it seems like great.

I: The that fact that you said you felt like everyone else might do it. And that initially, it seemed to motivate you and then you just kind of were like, eh, maybe not.

R: Yeah. So to really motivate me to do something, just a little bit of stressing me out doesn’t do enough. I have to actually think that I really need to do it to do something like that.

I: OK.

R: But coming back second look and like realizing that my classmates were all the kind of people who really-- sorry, not all of them. But the stereotype med student, where they’re like, did you do all the prep work? Blah, blah, blah, blah, blah. And
so, then I was like, oh. If I don’t do it, am I going to be behind? But still not quite enough because I tend to not really-- I don’t know. Yeah. I tend to be fine with that.

I: So you felt like maybe your classmates were very gung ho. We’re going to do it and you might be left behind?

R: Yeah. A little bit.

I: OK.

R: Needing to catch up. But, yeah.

I: And so for you, what’s going through your mind when you’re trying to decipher, should I do this? Should I not? Even if I do get a little bit behind. What are you saying to yourself at that point?

R: I mean it’s not entirely rational. I could rationalize it, but a lot of it is just like, right now I’m not going to do this. Am I going to do this now? No.

Int 14, [00:23:22.45]

This student did not persist due to some technical difficulties, but had those not been present, they would have persisted. They also mentioned the effect of immediate feedback on their learning.

I: Let’s say that the logistics were taken out. That your technological issues were taken out. Do you think you would have done more of the platform?

R: Yeah. I think I would have done more of it. Yeah.

I: And what would have kept you going?
R: Just how satisfying it was to go like, you just go through-- you get little questions. It's all in sequence. So it's very easy. I don't have to think about things. I don't have to open up different windows or take notes. It's all there. That was very nice. And to move directly from a nice, well put together video, to one question right afterwards.

So I can use my short term memory, but also confirm it. And then discuss whatever-- that was good.

I: So sort of the immediate feedback.

R: Yeah. The immediate feedback. And smooth working is so key. That it works smoothly. Int 14, [00:32:42.97]

This student, who was a non-completer, stated that since they felt the material was not applicable to them, they did not feel the need to complete it.

I: was there anything about the platform that could've been different that would've changed, I guess, your time priorities or your time allocation to the project?

R: Well, if the platform was part of my PhD requirements that I needed to do it, then, yeah, I would have done it as a requirement. But since it's voluntary, I just was like I'll do it when I've got the time.

Int 10, [00:38:54.24]

High Return on Investment (ROI) was a code used when students felt like doing the coursework was worth their time. Again, many students saw the explicit connection from basic science to bedside as the main reason. This student described having a strong background in physiology but still going on to complete the modules.

R: Yeah. So the way physiology was taught was very clinically oriented. It was very insightful in a lot of ways. I think physiology is the one that if I hadn't really enjoyed
it as much, then I would have probably not done it. Because I felt comfortable enough in it.

I: Yeah.

R: But [INAUDIBLE] was learning something valuable so I wanted to continue. And biochemistry— I mean, I guess if I were to go through it and I realized that I didn't remember very much. Or that I was learning helpful things from it then I'd been more likely to progress.

Int 12, [00:30:49.71]

This same student went on to state the enjoyment of going through the modules.

R: I actually sort of enjoyed spending time with the modules and so, I wanted to make sure that I finished it. Especially physiology. Physiology I thought was— I mean it had more equations and things that spoke to me…But immunology I really needed, I think, to get that basic level of understanding.

Int 12, [00:23:16.14]

This concept of enjoyment was echoed by several other students. As this one stated:

R: I found it interesting. I found it engaging and didn't dread doing it. It was kind of fun. Int 4, [00:11:15.67]

This student went to the extent of stating how the HMX platform changed their opinion about online learning in general. Again, there is an explicit transition from an extrinsic motivation to initially engage in the material to a more intrinsic motivation to persist.

I: Do you think HMX changed your attitude towards online learning at all?
R: Yeah. It made me think that Woah. Online learning could be great. I wish it were like that now.

I: [LAUGHS]

I: So tell me a little bit more about it. What was your impression of online learning before you went through HMX?

R: I thought it was going to be incredibly boring.

I: Yeah. And what, specifically, did you imagine when you were talking about it being boring?

R: So in all those little things where you get CPR certified, you're looking through this stupid thing. And it has all these bullet points that don't really mean anything. Or it's just text and you have to scroll through a bunch. And you don't get any sort of reward in between. Whereas, HMX it had those videos. Which are initially I was like, oh no. They're going to be so boring. But they're actually pretty engaging and concise and clear. So that was nice. And then having the questions immediately afterwards, and having little bits of text that were broken up, that was nice. They really made a nice product. They made it easy to go through. Easy to learn as like a first best thing.

Int 14, [00:42:28.57]

This student discussed initially going through the coursework as a valued experience for filling in perceived deficits, but then as they progressed, realized the value of clinical scenarios. Even though they had a strong background in physiology, they completed the lessons. As they stated:
I: You have a relatively strong background in at least physiology, so did that affect your wanting to go through it at all, positive or negative?

R: No, so like I said, for me, because I had the background in it, I still could see where there were gaps. For example, as soon as we started throwing equations into the situation, I could tell that I didn’t remember certain things. So that was kinda my reasoning for going through it. And with that they put in the clinical application is a completely new way of looking at it, because when we do it in class it’s just kind of theoretical and it may or may not relate to medicine. And when you put in the section in the clinics, then this an area that many of us may not have even touched. Even though I may be in biomedical science, may not have necessarily been applied in that same manner. So, it kind of makes it new and fresh in that sense and that makes you want to still look at it. Int 18, [00:27:25]

One of the other design factors that students mentioned was the aspect of self-pacing. Per adult learning theory (ALT) that sense of autonomy and control over what you are learning leads to more willingness to engage in the material. This was discussed by this student, who stated:

I: What elements of the platform do you think were most conducive to your learning?

R: I think the videos, just having like the audio and the visual come together with like, [instructor’s] team trying things out and pointing to things. And being able to watch things at a higher speed for when I felt like I was really comfortable with certain things-- that was helpful, too. Int 13, [00:45:20.18]

This student discussed the scuba diver example and the explicit transfer of concepts. As was stated here:
R: I loved it. I really, really liked the interface. I thought the first module, which I think was a scuba diver module, was just so well done. And I was just kind of wowed by the effort that had been put into designing it. Because I thought it was very clear. The example videos were clear. The instructional videos were short enough so that I was willing to sit through it. But it was concise. And for me, when I learn, I need concrete examples. And one of the things that I’ve often found in the basic sciences is I can't see it, I can't visualize, I can't connect with what's going on in the cells to really be able to understand what's happening, versus physically being able to picture or just picture it in my head. So the scuba diver example, I loved that. In physiology, there was another example, I think, with the cork and the champagne model, which I thought, again, was just a really neat way to illustrate the concept. Because everyone can visualize that or relate to that and know what's going on. So I just thought that the interface was great. And I really enjoyed the course. Int 7, [00:19:06.28]

Lastly, some students stated that they always finish what they started. This was coded as need for closure.

I: What kept you going? You signed in, you saw what it was. What kept you going?

R: Well, I like to finish the things I start. That's part of it. A little of anal retentiveness, you've got to make sure it's all done start to finish.

I: You like the green checkmarks.

R: Yeah. In fact, I just logged into it just a little while ago to make sure I-- in my mind that it still says, In Progress, because they keep it open so you can go back to refer to it. In progress? What did I miss? Do I need to go back? Did I forget to
answer a question? What's going on here? So that's certainly part of it. I found it interesting as well. It was nice.

Int 1, [00:35:21.89]

This was echoed by this student who stated:

I: What factors made you motivated to keep going, to finish it?

R: Well, in general, I don't not finish things I start…So I mean I wasn't going to-- I guess if it was awful I would've stopped. But even then I probably-- I don't like to not finish things. So I think I probably would have thought, oh, maybe the next one will be better and I probably would have kept going anyway. But at the same time, it's free information, if that kind of make sense, free enrichment. And it's kind of-- it's hard to pass that up. Even though I guess I haven't sought out online courses or those sorts of things it's not because I'm not interested in doing it, it's just I wish there were like 48 hours in one day and not 24 because then maybe I could. But in this case, it was very manageable. So I thought if someone's going to teach me information and all I have to do is listen and be on my computer for an hour a week or so. I can definitely do that. Especially, over the summer, before I have so much I need to worry about.

Int 11, [00:30:17.57]

3.0 Discussion

Herein are presented several different educational and psychological concepts and dichotomies relevant for an evaluation of the motivating factors for student persistence in on-line education. Before delving into this discussion, it is imperative to again discuss that this research was conducted on a small subset of self-selected students who were exposed to a
singular learning experience. Not surprisingly, those who enjoyed the material did more and were more willing to talk about their experiences. Although this is a small selection of participants, the fact remains that these students exist as a subgroup of medical learners. This, along with the limited qualitative research on motivation in medical education, especially e-learning in medical education, makes this research relevant regardless of the generalizability of the results (R. A. Kusurkar et al., 2012). This was conducted as a pilot study and underlines the need for further research on the intersection of medical education, e-learning, and motivation.

In the medical education world, the conceptual frameworks discussed in this study are vital to understand optimal teaching strategies in a profession in which lifelong, self-directed learning is essential. Medical education has been under various pressures to make learning more effective, efficient, and safe (Jones, Hofmann, & Quinn, 2009). In the 21st century digital age of learning, medical education is transitioning from a vertical information transfer to a multi-source information integration and application model (Prensky, 2001). There has been a call for earlier patient interaction to better contextualize pre-clinical learning and facilitate transfer. In this vane, many schools have decreased the pre-clinical time devoted to medical school, and have sought out more creative ways to deliver content, often relying on various educational tactics including, problem based learning, team based learning, and e-learning.

The motivational processes that were seen in this subgroup of students were, overall, extrinsic in nature. It is widely recognized that not every learning activity can be driven by intrinsic motivation and, generally, one sees, a mix of intrinsic and extrinsic factors driving the learner.

Once the interview data had been analyzed, a pattern started to emerge. The most common motivating reasons cited for initiating work on the modules were thematically aligned with a perceived threat or fear, both from the future HMS coursework, and from a new normative
environment of peers. The most discernable examples of extrinsic motivation were found in those students who had an obvious external regulation. These were the students who stated that they essentially did the modules because they were told to or they had a general sense of obligation. Those who came under introjection had more ego involvement and would often say they “needed to do it” because of sense of background deficiency or some other sense of needing approval from themselves or others (i.e. peers or instructors). Students who aligned more with the identification regulatory style often had some sense of value added to the activity. These were the students who often said that they “wanted to do it” or “I’m sure that I did this will help at some point.” Most students were categorized under these three regulatory styles and there was strong evidence for performance goal orientation. Students often referred to the future curriculum or to performing well on assessments when asked about their intentions.

When asked about persistence, many cited increased internally regulated motivations along the OIT continuum. Also, those who commented on the differences between the physiology and immunology sections stated design elements that engaged them more in one over the other. Many of the design factors that they commented on led to more autonomy, more self-regulated learning processes, and were elements traditionally targeted to facilitate adult learning. Specifically, students mentioned enjoyment and having fun completing the modules. They also mentioned the interactive diver, connections to real-world experiences, connecting with the professors, the clinical applications of basic science topics, the quality of the instruction, and the self-paced aspect. These elements can be traced back to adult learning theory, self-regulated learning processes, self-determination theory, and the sense of autonomy, competence, and relatedness (R. A. Kusurkar et al., 2012; Ten Cate et al., 2011; White et al., 2014).

Although it is hard to generalize on such a small population, the students interviewed tended to cite specific design elements that moved them along the OIT continuum as they
persisted through the material. As students progressed along this continuum after being exposed to the curriculum, many specifically stated things were enjoyable, engaging, and fun. Out of those who were non-completers (5 out of 17), three were not primarily seeking an MD. Those that did not persist named the lack of these design elements in the immunology modules and/or the lack of proximal application of the material for their course of study (HST or dental students). It is possible that the proximal application of content and early clinical exposure that motivated so many of other students did not resonate with these individuals. It is also important to note that, physiology tends to be easier to understand for medical students due to it being based on scientific principles that they have learned previously, whereas, immunology is an entirely new concept to most students.

Self-determination theory (SDT) is a dominant concept that is the basis for many other conceptual frameworks. SDT describes that humans by nature want to learn and develop knowledge (Lyness, Lurie, Ward, Mooney, & Lambert, 2013; Niemiec & Ryan, 2009; Ten Cate et al., 2011). The OIT model is a subset of SDT that describes intrinsic motivation and several different types of extrinsic motivation with variable levels of autonomy. Niemiec and Ryan state that “a large corpus of empirical evidence based on SDT suggests that both intrinsic motivation and autonomous types of extrinsic motivation are conducive to engagement and optimal learning in educational contexts” (Niemiec & Ryan, 2009). They went on to state that “evidence suggests that teachers’ support of students’ basic psychological needs for autonomy, competence, and relatedness facilitates students’ autonomous self-regulation for learning, academic performance, and wellbeing” (Niemiec & Ryan, 2009). Kusurkar et al. discuss the cognitive, affective, and metacognitive component of learning. They state that “motivational processes may be a substantially undervalued factor in curriculum development.” They go on to conclude that “building curricula to specifically stimulate motivation in students may powerfully influence the outcome of curricula” (R. A. Kusurkar et al., 2012).
Deci and Ryan describe evidence that students can shift their motivation orientation to learning as they actually go through the material, especially if they find intrinsically interesting properties (Ryan & Deci, 2000). They discuss that based on the work of several other studies, the more autonomous the extrinsic motivation is, the more likely students are to engage with material, persist with the material, have higher achievement, have overall better sense of well-being, and have more quality learning experiences (Ryan & Deci, 2000; Ten Cate et al., 2011). Kusurkar et al. also discussed the benefits of supporting learning autonomy and motivations and better learning outcomes (R. A. Kusurkar et al., 2012). They also state that “these types of motivation endorsed by the students are considered important in predicting how students adjust to their study, how much effort they are willing to invest in their study, performance in medical school and preference of specialty” (Rashmi a Kusurkar, Croiset, Galindo-Garré, & Ten Cate, 2013; Ten Cate et al., 2011).

The difficulty in e-learning experiences, especially in medical school, is achieving this sense of autonomy, competence, and relatedness. Medical school curricula are often seen as externally regulated, imposing on their students what they need to know. This strong perceived external locus of control can be at odds with the overall mission of medical training in creating lifelong learners. To create lifelong learners, instructors must develop a learning environment that supports and fosters self-regulated learning processes. When using CAI as a stand-alone or part of a blended learning model, it is important to understand the design factors that students perceive that support autonomy, competence, and relatedness.

The Association of American Medical Colleges (AAMC) established a committee to look at innovation in medical education. The Institute for Improving Medical Education (IIME), developed principles to effective e-learning instruction. Many of the principles discussed were utilized in the HMX Fundamentals modules including real world everyday experiences to gain attention and activate prior knowledge, basic science principles extracted and explained from
the everyday experiences to facilitate transfer, clinical applications of the same principles to
again facilitate retention and transfer and provide a proximal application of the knowledge,
interactive case scenarios and questions to make the learning more active, and instructor led
virtual didactics to provide the content and contextualize the learning (Chandler, 2007).
Severino et al. discussed principles of distance learning that serve as positive motivators
including interactivity, learning by doing, dynamism (just in time skills), modularity, flexibility,
multimedia, and human interaction (Severino et al., 2011). Many of these design elements were
built into HMX Fundamentals and were commented on by many of the students.

This study examined the motivational factors that led students to initially engage in an
optional online learning experience prior to starting medical school and the design factors that
led to persistence through the material. As these topics were explored, it became clear that
many of the motivational factors that addressed research question 1, were on the less
autonomous spectrum of the extrinsic motivation. However, the design factors that led to
persistence seemed to support autonomy, competence, and relatedness and seemed to be on
the more autonomously, internally regulated spectrum of extrinsic motivation with students even
moving to intrinsic motivational factors. Although this study was a small sample size of self-
selected learners, some of the factors that were discussed have been shown to be efficacious in
other studies (R. a. Kusurkar, Croiset, & Ten Cate, 2011; Rashmi a Kusurkar et al., 2013; Ten
Cate et al., 2011). These findings, once further researched, may assist in the development of e-
learning experiences for medical trainees. As this was a pilot study, many of these findings
should and will be further studied to elucidate the roles each play in the support of e-learning
and medical education with respect to self-regulated learning and fostering lifelong learning.

Under self-regulated learning, it is important to note that “these types of motivation
endorsed by the students are considered important in predicting how students adjust to their
study, how much effort they are willing to invest in their study, performance in medical school and preference of specialty” (Rashmi a Kusurkar et al., 2013; Ten Cate et al., 2011).

The need to know, willingness to learn, and orientation to learning tenets describe that adult learners need to realize a return on investment (ROI) for their learning and see the proximal application of the material to their lives and work (What is the purpose of learning this?). For the HMX modules, this was manifested in the bedside patient encounters and the explicit explanation of how basic science concepts are used at the bedside (e.g. partial pressures application for an ICU ventilator). This was very well received by the students as many specifically mentioned that this motivated them to persist in the material and “made it fun.” Several students mentioned the concept of ROI for the material. As medical students are flooded with very large volumes of difficult to learn material, they tend to become excellent at assessing whether certain efforts are worth their time. For the small subset of students who engaged in the material and persisted they often specifically mentioned seeing a high ROI with completing the material. Many students specifically mentioned that physiology was much better at making this transfer of concepts from basic science to the bedside. Physiology easily lends itself to this transfer and seems to be conceptually easier to understand than immunology. As a non-intentional design factor, immunology did not have as many of these explicit bench-to-bedside elements. This was called out by several students who wished that immunology had more of these design elements, with a couple students going so far as saying this was the reason why they did not persist in the material.

The concept of self and autonomy was manifested by learners enjoying the self-paced aspect of the course and the modularity so they could select the sections that were most beneficial. Several students stated that they wished they could speed up certain videos.
The need to draw upon past experiences was manifested by the real-world life examples that were built in as mystery introduction videos for the modules. Specifically, many students mentioned the diver scenario as elevating their curiosity. Even one student who had scuba diving experience stated they could relate but did not fully understand the physics and physiology behind the experiences. These were illuminated by going through the module to reach a deeper understanding. David Perkins discusses the concepts of different types of fragile knowledge. He described missing, inert, naïve, and ritual knowledge (Perkins, Perkins, Grotzer, & Grotzer, 1997). Ritual knowledge tends to be superficial and leads to inability to transfer. This can lead to students learning how to calculate partial pressures in college but not how to apply them in novel contexts. When the transfer is made more explicit and applied this can lead to a deeper understanding and when faced with a novel context can assist with problem solving (Perkins & Salomon, 1988). As described above, when students gain this sense of competence by going through learning material, it can lead to more intrinsic motivations and improve persistence (Niemiec & Ryan, 2009).

The counter argument to the design elements leading students down the OIT continuum, was that those who were willing to interview and talk about their experiences had a positive experience. One can expect those who enjoy doing something are more willing to do more and to talk about their experiences. This is compounded by the observer-expectancy effect, when considering that the researcher who was conducting the interviews had been involved in the development of the HMX platform. This was attempted to be mitigated by the statement of research at the beginning of every interview and the explicit statement that the researcher had no financial interest in HMX. This is still a concern and in future interviews, it will be worthwhile to have an interviewer relatively unaffiliated with the tested platform.

Another consideration is that the persistence rates were much higher in both groups as compared to MOOC data (65-67% as compared to 6-7%). Medical students tend to be highly-
motivated, whether due to intrinsic or extrinsic factors, and are a different population than those who undertake MOOCs. It is important to note that again this study was done with the 2015 pilot version of the HMX platform and there has been considerable change and updates since that time.

Other arguments against the results are concerning for confirmation bias. The results of the coding, content analysis, thematic development could have been influenced by the deductions made by the researcher. This, however, was mitigated by an inductive analysis, in which all the coding had been completed prior to any conclusions being reached. Further research during the analysis phase into motivations types and the OIT was what led to the thematic development and ultimate conclusions. Also, any concern about selecting quotations that confirm the study findings was mitigated by including as much of the quotations as possible to give the full context of the selected passages.

Another consideration is that students had poor recall for their initial motivations and may have been clouded by them already undergoing the HMS residential coursework. Those elements that made the largest impression, may have been easier to talk about as opposed to negative reactions. This is a fundamental issue with any research study based on recall (recall bias). The interviews were conducted as soon as they could be scheduled following the exposure to HMX.

Overall, the findings in this study seem to support movement along the OIT continuum, in part, due to the above-mentioned design elements. Although this study was conducted with a CAI that was a stand-alone, there can be some consideration for the previously mentioned concept of flipped classroom. Flipped classroom is a type of blended learning experience in which some combination of in-class and out-of-class learning is utilized to achieve the learning objectives. It is a more learner-centered model of instruction that utilizes cases, papers,
chapters, and, more recently, computer assisted instruction, to help deliver content prior to the classroom. Various forms of e-learning have been utilized in this model, from video-taped lectures to specially designed, interactive, instructional modules. Critics of the flipped classroom are concerned about the passive nature of learning from instructional videos and the requirement of highly self-regulated learning behaviors. Much time and effort is required from the instructors and institution to develop these modules, resulting in variable quality and effectiveness. Limited research has been conducted on studying motivation, learning process, and goal orientation in computer-assisted instruction in medical education.

The flipped classroom has been implemented in many medical schools. In 2013, Stanford Medical School introduced a flipped classroom model as a way to “re-imagine medical education...[to] make better use of the fixed amount of educational time available to train doctors” (Steakley, 2013). Incidentally, in 2015, Harvard Medical School (HMS) introduced a new curriculum that employed several techniques that can be considered as flipped classroom. This same student cohort was the first to experience HMX Fundamentals prior to their matriculation into HMS. Although HMX’s goal was not to develop this content as part of a flipped classroom, some of the findings in this work may be applicable to CAI associated with blended learning models.

Even outside the e-learning and flipped classroom realms, further study into motivation and learning may be able to identify and remediate at-risk students. Some international medical schools have looked at at-risk learners who display ineffective learning processes, misdirected metacognition, and misaligned motivations. Their remediation programs have been utilized to promote self-efficacy and demonstrate sustained improvements in academic achievement and performance (S. Malau-Aduli et al., 2013). Better abilities at identifying these at-risk students, and understanding the underpinnings of low self-efficacy and competence, may lead to earlier and more effective interventions. Also, with understanding the negative cognitive-emotional
states in medical student populations may help identify student and future doctors at risk for burnout.

4.0 Conclusion

The goal of this study was to further understand some of the motivations of a select group of learners in an optional online learning experience and to shed light on some of the design factors that students believe contributed to their motivation and persistence in undertaking this coursework. For this select population of learners, it was concluded that many design factors led students across the OIT continuum to a more autonomous, internally regulated form of extrinsic motivation, and, in some cases, even to intrinsic motivations. This study may stimulate future work to understand drivers for affecting change in motivation and cognitive-emotional states to facilitate self-directed learning and self-regulated learning processes in computer-assisted learning in medical education.

4.1 Recommendations and Future Research

This pilot study looks at the intersection of medical education, e-learning, and motivation. Further work in this area should focus on other sites and other populations to look at specific design elements that promote intrinsic motivation and self-regulated learning processes to better support lifelong learning. Based on the findings in this study, there exists a subpopulation of students who may start out as highly externally regulated learners but with design factors that support adult learning theory and promote self-regulated learning, students may be able to move along the OIT continuum. The transition from performance goal orientation to mastery goal orientation merits further study in an era of incessant medical education assessment and high levels of anxiety, depression, and burnout (Dyrbye et al., 2014; Villwock, Sobin, Koester, & Harris, 2016).
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6.0 Appendices

6.1 Abbreviations

ALT – Adult Learning Theory
HMS - Harvard Medical School
HMX – External Education Online learning platform of Harvard Medical School
MIT – Massachusetts Institute of Technology
HST – Health Sciences & Technology track combining coursework from Harvard Medical School and Massachusetts Institute of Technology
OIT – Organismic Integration Theory (Subset of SDT)
SDT – Self-Determination Theory
SRL – Self-Regulated Learning
SE – Self-Efficacy

6.2 Qualitative Questions with Probes

1. Please tell me a bit about yourself. What are your interests/hobbies?

2. Describe your experience using online materials prior to this experience?
   Probes:
   i. What did you especially like?
   ii. Dislike? Why?
   iii. How did this compare to your experience with this platform? Why?

3. How does this online experience differ from previous online learning materials you may have used? How so?

4. How much of the materials were you able to experience?
Probes:

i. What specifically about the materials led you to target those lessons?
ii. What prevented you from completing more?
iii. What would have to change for you to complete more?

5. What specifically led you to participate in the course?
   a. Probes:
      i. Affect that it came from your future school?
      ii. Affect of your professors?
      iii. Quality of material?
      iv. Curiosity?

6. What time of day and where did you complete the largest portion of the material?
   a. Probes
      i. Why did you choose that time/place?

7. What specifically were the most memorable and/or valuable aspects of the online experience? (Content or element) Least valuable?

8. What was your experience with the discussion boards?
   a. Probes
      i. How did you use it?
      ii. Did you interact with peers?
      iii. How would you change the discussion boards?

9. Would you recommend this material to your student colleagues?
   a. Probes:
      i. Why? Why not?
      ii. What specifically would you tell them?

10. Do you think this material is important to know prior to medical school?
    a. Probe:
i. Would you have otherwise studied this material prior to starting medical
   school?

ii. Why? Why not?

11. In your mind, how do you define preparedness for medical school?

   a. Probe:

      i. Did you feel prepared at the beginning of the summer?

      ii. Do you feel this learning experience has changed your preparedness?

      iii. How so?

      iv. Did you do anything else to prepare for medical school

6.3 Codebook

See attached
**Research Question 1:** What self-reported factors motivated pre-medical students to initially engage in an optional online fundamental learning experience prior to starting medical school?

<table>
<thead>
<tr>
<th>1</th>
<th><strong>Background Deficiency</strong></th>
<th>Interviewee described need to do the material due to perceived deficiency in the presented subject areas and/or wanting to keep pace with the material.</th>
</tr>
</thead>
</table>
|    |                           | • *I:* So you think it was definitely something about your personal strength in those subject areas that was more of a motivation for you to go through the coursework?  
   *R:* I’d say that was probably one of the stronger motivating factors, yes, my personal background and wanting and needing to learn these things. Yeah. I’d say so. I did, I found it very interesting, especially the physiology, because I hadn’t ever had that before, and because my background was a lot weaker, it was interesting to see these things in action. Int 1, [00:34:53]  
   • *I:* Was there anything in particular about those subject matters that made you want to take the course?  
   *R:* Any of the subjects in medicine I probably would have been interested in learning more. I just don’t have the background. I would have enjoyed having that foundation. The immunology interested me because, again, I’d taken the course on it, so it was something I was somewhat familiar with. And I just wanted to have that review. Int 1, [00:37:36.82]  
   • *R:* I found out that it wasn’t required the same time I got the email.  
   *I:* Oh, OK. And so what made you still do it?  
   *R:* Because I knew I was weak in the subject.  
   *I:* OK. In those particular subjects?  
   *R:* Yes.  
   *I:* OK. Excellent. So any other motivations, any other reasons why you decided to look at the videos, or was it pure that you were uncomfortable with your background.  
   *R:* No. It was more just uncomfortable with my background. Int 3 [00:31:42.01]  
   • *R:* I don’t have the best background in immunology. And coming to med school, I thought it would be good to kind of get a refresher, start learning a little bit more about that so that when immunology courses do come around, it won’t be as much of a shock. Int 5, [00:14:40.06]  
   • *R:* I had taken some basic-- some of these have been covered in science classes, but not at a higher degree. I was particularly worried about the physiology when I started seeing the physic concept names. Because physics was a really tough class for me. Int 7, [00:18:05.46]  
   • *I:* So in knowing that this was completely voluntary, what made you want to sign in and actually do it?  
   *R:* So I guess it was two-fold. Since I didn’t think I knew very much immunology and I liked the idea of having the clinical applications, I thought that it would be a great way to bridge that gap between going from college to medical school. At the same time, I don’t really think I felt it was optional. I kind of felt that the majority, if not all of my classmates, were going to be
doing it. And that if I didn't do it I'd be behind. And so I don't know. At this level, I feel like nothing at least in my mind-- and not everyone sees it this way and I appreciate that-- optional means you should do it. And again, I guess the subject matter also mattered to me too. I thought, these are areas that I think I'm weaker in. Int 11, [00:27:06.61]

- I: you said it was something particular about the subject areas that drew you in.
  R: Immunology was pure necessity…That was it. I had no-- like very little interest in it. Although, I did some work that sort of barely touched immunology. I sort of liked that one little corner out in left field of immunology, but the rest was just like, I'm going to do this because it will help me. Int 12, [00:25:12.52]

- R: I was like, I can't be behind before we start. I'm sure at some point it could be a good thing that I did that.
  I: So that's a good question. When you initially got the email asking you to log on, what kind of things motivated you to actually log on and participate, let alone do all of it?
  R: Part of it was definitely feeling like I didn't want to start behind. Int 4, [00:10:38.82]

2 Unpreparedness Interviewee described general feeling of being unprepared to start medical school

- R: In terms of the school preparation, I feel that probably my biggest weakness was in sort of the general biology biochemistry background. I just took my biochemistry course this past spring, and I struggled with it as many people do. But I managed to eke it out. And so perhaps I could have been a little better prepared for that. You're never going to be able to learn everything. That's why you come to school, is to learn these things. I get that. But just through my background, I wish that I had had a better idea. Int 1, [00:23:51.00]

- I: So you said that even though it was voluntary, you felt that it was more required, I guess, in some sense? R: No, not required. Definitely voluntary. But required, perhaps, by peer pressure, but not required by anyone in the program, obviously. But if I had just come from working in an immunology lab for three years, maybe I wouldn't have felt that it was required. Maybe I would have gone through and seen, oh, this is what they're talking about. I know this. I'm not worried about this. But again, for someone without the biology background, without the strong medical background, it felt more required for me, trying to get everyone up to speed. (Int. 1, 00:34:02)

- I: HMX said maybe you should check this out. What kinds of things are going through your head when you're deciding whether to participate in something like that? R: I think, to be honest, I felt so unprepared coming to a medical school. But if they had said, go to this YouTube channel, and subscribe and watch the 25 videos on there, I think personally I would have done it. Yeah. I think that's just probably the fact of it. But I do think I was more motivated. I would have done it either way. Int 6, [00:36:35.79]
**Peer Fear**

Interviewee described being concerned about their intelligence and background compared to their peers and a general desire to keep pace with their peers.

- I kind of felt that the majority, if not all, of my classmates, were going to be doing it. And that if I didn't do it I'd be behind. Int 11, [00:27:06.61]

- I: So you said you struggled a little bit compared to your peers. Can you tell me a little bit more what you meant by that?  
  R: Well, I'm under the impression that at least a good number of them are just stronger readers and are able to comprehend things, partly because of their backgrounds, but partly because they just-- I don't know, they can read through something and get it sort of on the first pass, maybe even the second pass, with much more facility than I can, for whatever reason that is. And so I feel that I'm often a little bit behind the curve. I can get the material, that's not a problem. It just takes me just a little bit longer to string things together. And that might be just a couple of seconds, or maybe even a couple minutes. But I don't know what exactly it is. Maybe it's that I'm not preparing as well and I'm feeling a little bit behind. Or maybe it's just an observation bias or something. I'm not quite sure. But that's the feeling that I get.  
  Int 1, [00:09:28.42]

- I: So you said that even though it was voluntary, you felt that it was more required, I guess, in some sense?  
  R: No, not required. Definitely voluntary. But required, perhaps, by peer pressure, but not required by anyone in the program, obviously. But if I had just come from working in an immunology lab for three years, maybe I wouldn't have felt that it was required. Maybe I would have gone through and seen, oh, this is what they're talking about. I know this. I'm not worried about this. But again, for someone without the biology background, without the strong medical background, it felt more required for me, trying to get everyone up to speed. (Int. 1, 00:34:02)

- I: When you first got the [invite] email, what did it make you think?...  
  R: Yeah, I had just gotten back from working abroad for a year, and it had been a year and a half since I had seen my family and friends, and I was kind of looking for to just relaxing and spending time with them, but I was kind of a little bit upset that I had to do-- I mean, I didn't have to, it was optional, but I felt held to do this work.  
  I: tell me a little bit more about that feeling…tell me more about feeling compelled.  
  R: I guess when I'm getting into this medical school and so when I got in and I decided to go, I felt intimidated. I thought the other students would be at a higher level and I would really need to do everything I could to just be able to keep up. So I really felt like I should do this to—  
  I: And I guess the intimidation, [was it] a general feeling of intimidation? Or is it, like, intimidation for certain subject matters?  
  R: I think it was a general feeling of intimidation. And I also thought that the quality of the incoming students would be so high that-- and everyone would be so kind of on top of things that everyone would do this, and if I didn't, I would be the odd one out and I might be put at a disadvantaged when classes start. I didn't want to already be behind in classes. (Int 2, 00:19:29.05)

- R: you're not going to be the smartest, either. And you're definitely not going to be the smartest at everything. So trying to
prepare yourself for being in a classroom unlike any I've ever been in, with people who, at an intellectual level, on average, much higher than anything you've ever been in before, and not getting knocked off your game because of that. So getting used to it and enjoying it, instead of having it be something that is very intimidating and really hurts your self-confidence. And I think that that's the case for-- many people come in to med school and find it really challenging. Eventually that could be one of the reasons, is feeling that they're-- the impostor syndrome, which we've talked a lot about, of feeling like you don't actually belong, and they made a mistake letting you there. Int 4, [00:14:50.10]

- R: I said, I had no background and really no background in anything we're talking about all. Very sort of basic bio-chem can and basic genetics. And that was really it. So I felt like having me a lot of my future classmates, some of them had PhDs and biochemistry and things like that. I probably needed to do some kind of-- something to catch up. And it was. Yes. I think the motivation was there to do whatever I could to be prepared, to show up ready to go. Int 6, [00:19:58.52]

- I: So in knowing that this was completely voluntary, what made you want to sign in and actually do it?
R: …I don't really think I felt it was optional. I kind of felt that the majority, if not all of my classmates, were going to be doing it. And that if I didn't do it I'd be behind. And so I don't know. At this level, I feel like nothing at least in my mind-- and not everyone sees it this way and I appreciate that-- optional means you should do it. And again, I guess the subject matter also mattered to me too. I thought, these are areas that I think I'm weaker in. Int 11, [00:27:06.61]

4 Awaken the Mind

Interviewee described a desire to get back into learning after time off or from the summer months.

- I: take me from your first impressions, when you first got the email from the HMX Fundamentals, to you actually logging in and actually taking the course. what was going through your mind? Feelings, attitudes, things like that.
R: Oh, I was very excited. It was a great opportunity to get things going a little bit early, just get the ball rolling, get the juices flowing, and get me thinking about things. Int 1, [00:32:57.35]

- R: And I felt, again, it was a good way to keep my mind focused on what was coming up ahead, to focus on medical school. It was nice. It also gave me sort of a distraction sometimes. I got a little bored over the summer, too. Just itching to do some work. Int 1, [00:36:33.10]

- R: Once I started doing it, I felt like oh, now I'm getting into working again. I haven't been in school for three years, but it was nice to get back into it. And it was a good way to ease into doing more of it on the-- because now I'm doing three of them a day. Int 4, [00:11:39.87]

- I: What was your first impression when you got the email from HMS about signing up for-- or logging on to HMX? What was your first impressions?
R: I was expecting it. I'd gone to revisit. And they had talked about-- look for this email. And I looked forward to it. I like to try to go and do in the experience as prepared as I can. And I thought it would be a great way to start thinking about-- so it was optional. So I knew I wouldn't be like mandatory [INAUDIBLE], but I thought it would be a good way to kind of transition from doing nothing over the summer mode to kind of thinking about things that are relevant. Yeah. So I was looking forward to going
through it. Int 6, [00:18:16.74]

- R: And it kind of was reinforcing my commitment to put in the time to med school and start easy over the summer. Int 7, [00:22:59.16]

- R: I think in all of the different course topics within, I felt that I needed to brush up on it. It had been a while since I had seen those terms and concepts, at least a couple years. So I really felt that it was nice to just be familiar with one, the topics, but two, also just the process of learning and taking little quizzes. In my gap year, I didn't do any of that. So it was just nice to brush up on that too. Int 7, [00:29:59.36]

- R: [Coming] in having not been in school for a year and having not seen any lectures or have to think about these sorts of problems again. It was nice to have the opportunity to do that. Int 11, [00:13:14.62]

- I: When you got the e-mail, what was the motivating factor for you actually signing on and checking it out? What were you thinking when you were doing that?
  R: Well, I think I was kind of excited to start grad school, and so it was like, here's the first piece of my PhD program or something. I just wanted to see what kind of stuff I would be learning. And it'd been like a while since I'd taken any classes. So it was like now I get to study and learn a cool thing-- medical stuff related. I think it was mostly like I was excited to start grad school and the topics seemed interesting. Int 15, [00:36:37.93]

5 Sneak Peak

Interviewee described that they wanted a preview of the scope, style, difficulty of material, and/or their professors that they may see in their residential courses

- I: What was the effect that it was going to be your professors that's actually going to be teaching the course on your wanting to sign in and do the coursework? Did it have any effect?
  R: Yeah, I'd say an effect. It certainly wasn't the main one, but the fact that, if they had just said, here, watch these videos on YouTube from some guy somewhere, then I probably maybe would have done it. But it's not the same as, this is the individual who's actually going to teaching you, so you're not going to be learning superfluous things. You're not going to be learning things that he doesn't want you to know specifically. And so that motivated me. Int 1, [00:36:47.46]

- R: And also knew that we were going to have this flipped classroom. So it was a good opportunity to try it out. Int 3, [00:32:19.60]

- R: I felt like it was a really good way to kind of get introduced into what we were going to be doing in our curriculum, while also learning a lot. Int 4, [00:06:15.27]

- R: I imagine that if it had been oh, by the way, in case you want to do this prep work, Stanford has these videos. Take a look at
them. If that had been it, I probably wouldn't have done it. But since it was this is some HMS stuff, kind of like what you're going to be doing, very relevant to what you're going to be doing, then yes. Int 4, [00:21:29.30]

- I: Before you had started, did you feel like this was essential learning material that you needed to complete?
  R: Yes. I guess I thought, before I started, that that was something that I needed to do. I thought our stuff in class was going to be based off of it...I also was curious to see what it was like. I was curious to see if this is going to be like what class is like. What is it, exactly? And what is the curriculum going to be like when I start? That was definitely a really appealing aspect of doing it...I was under the impression, and I probably just didn't read it very clearly, that the material was kind of an intro to what we'd be doing, and the what we would be doing class was based off of it. Because it did make it seem, at least-- they did seem to say we want everyone to do this. And so I just kind of assumed that what we would be doing would be based off of it, and I think eventually it probably will be...Since it was this is some HMS stuff, kind of like what you're going to be doing, very relevant to what you're going to be doing, then yes...It was definitely a draw to see so what is it exactly that these videos are about, and what are we going to be doing. I probably still would have done it, but I may not have had that extra motivation to do it. Int 4, [00:25:58.60]

- I: What was the effect of the fact that this was coming from your future professors on your motivation to participate?
  R: It definitely increased my motivation to participate. Another reason I actually did the immunology is I saw that it was-- the lectures where by Dr. [professors name]. And I've heard a lot from my friends in undergrad about how awesome of a professor he is. So I thought it would be cool to see how he explains things. Yeah it was definitely a motivating factor. But I wouldn't say that it was the motivating factor. It helped to have this in a platform because I know that there are so many videos out there on YouTube that probably explain the exact same concepts in the exact same way with probably just as good video quality. And so it did help that this was specifically HMS. That did motivate me. Int 5, [00:16:25.09]

- I: What was the effect that the instructors were going to be your instructors on your motivation to participate?
  R: I think it was a positive motivation. I had heard about some of these people before. I've had some friends that have been there a while. I talk about in particular like [professors name] what a great teacher he was and how engaging he was and what a great guy he was, and all that stuff...I think it's part of being in this branded curriculum, you want to be supportive and try whatever the new thing is and give honest feedback. So I think, yeah. I think that it was a motivation to put your best foot forward and try things. Int 6, [00:32:57.54]

- I: What was the effect that this was going to be your professors teaching this course, as opposed to somebody else's professors?
  R: Oh, I thought that made a huge difference. When I saw [professors name] in person, it was like seeing a celebrity...I thought it was-- I felt a greater connection to the material. I knew that-- I was amazed at how much time the instructors have put in to developing this content, finding the patients to interview and all of that. So I had a lot of appreciation for the time that went into these modules. And it made me want to take advantage of it more, given that I knew it was tailored by my professors. It was really meant for us to go into our curriculum. So I thought that really helped. Int 7, [00:26:55.59]
I: What was the motivating factor for you to actually sign into immunology? What made you want to do it?
R: I think partly feeling like this is a good thing to do, like this is the version of me as a student that has better study habits would be engaging with the material earlier and more often than I historically have done. So that, plus being pretty curious about what level of detail is med school going to be operating in?
I: So you sort of saw it as a reflection of what you’re going to be doing, essentially.
R: Or some insight to it, yeah. Int 8, [00:22:44.39]

R: I was curious how you would structure a medical course as an online course, especially since there are certain parts in medicine where I thought like, you know, histology and things where when I did pathology at HMS, I really appreciated the hands-on things I did. And I was curious to see how such things could be in a course that's online, so I wanted to see, what would they focus on? And what are the gaps that you would not glean from an online medical course? Int 10, [00:33:26.49]

Interviewee described that they thought the coursework would be worth their time based on multiple factors

R: I think assuming that they were kind of also elevated it but because of the great reputation the faculty has here. Int 2, [00:25:44.40]

I: Do you think that there was an effect the fact that it was your school putting it on?
R: I do, but I think more powerful than that is just the fact that it came from one of the top universities in general. I think if Stanford had emailed me, it would have been similar. I would have respected the professors and [?] everything like that as well.
I: So is it more about the university itself and the kind of your perceived notion of its--level.
R: Yeah. Int 2, [00:26:19.27]

I: Did the fact that your professors were teaching it, did that have any effect on you?
R: Oh, yeah, definitely. I think if it had been someone not affiliated with HMS, I probably would have been way less likely to do it. Because I think, one, it showed institutional buy-in, and it already gave me a sense of the quality of the teaching that was going on.
I: So quality and buy-in.
R: Mhm. Int 13, [00:34:02.57]

I: If this was another elite institution, let's say Stanford, that was putting this out, do you think that you would have the similar motivation to participate prior to starting med school, or you think that it was something specific about HMS that you were going to be a student at HMS?
R: I think that it was institutional recommendation that is that you do this that was one of the big motivating factors. But I don't think it mattered that it was HMS's professors. For example, if HMS had said, we're working with a project from Stanford and Stanford's doing these videos. You guys should test them out, that that would have definitely motivated me to do it just as much
as having HMS as professors. So I think it was definitely having that-- the weekly reminder emails, and HMS saying hey, this is something cool that you guys should check out, that was the main motivating factor. But who the professors are, from which institution, that kind of stuff isn't I think as big of a difference. Int 5, [00:17:33.25]

- R: I guess it was neat to be instructed by Harvard professors, who may or may not have been-- were going to be my professors. Because I respect them. And I thought the quality of the material that was going to be presented was going to be very high. And so I think, in that respect, thinking that what I was going to receive was high quality information. And I think that was certainly encouraging. But again, because I didn't think that either of them were actually going to my professors, that wasn't a big part of my decision. Int 11, [00:31:38.37]

### 7 Institutional Effort

Interviewee described a sense that the institution put in a great deal of effort in the production of the material and in a sort of social contract, they decided to participate.

- R: The material was very good quality. There was no doubt about that. The videos were wonderful. The bit of written material that there was fine. I think it was a very good quality. If it had been sort of slap dash, I don't think I would have stuck with it. If you're not going to bother putting time into it, then I'm not going to bother putting time into it. But yeah. I thought it helped. I thought it was quite nice. Int 1, [00:42:35.14]

- I: What was the effect of the quality on your willingness to continue to move through the modules?
  R: I think it was very impactful...As it kind of relates to what I was saying before about respecting the professor--...I could just tell that there was a tremendous amount of effort and coordination and time that had gone into [INAUDIBLE]. And when that's the case and when that's coupled with them actually doing a good job with all of that time and effort, which I felt was the case, then I was much more inclined to make use of it.

- I: So again, just like we talked about before, did this play into that respect factor? The competence and caring you talked about previously?
  R: Yeah...It definitely does.
  I: And was that a motivating factor for you?
  R: Yes. Int 2, [00:23:50.53]

- R: One of my professors, he was putting a flipped classroom together. And I was in his lab...So he told me all about how hard it is for them to record the videos and stuff. And so I figured if they're putting this much work into it, I might as well listen. Int 3, [00:32:19.60]

- I: What was the effect that it was your school that was putting this out?
  R: That's a very interesting-- I hadn't thought about that. I would guess that I would have been more likely to do it, if it was HMS and not another school, and feel a little bit more-- I guess it's a respect thing, too. These faculty put a lot of time into making these, and they want you to look at them, and expect you to look at them. And so, out of respect for them, I would look at them...I think that is a tendency in all my classes, of if they put all this time into making these videos and doing these
reading, yes, I'm going to spend a lot of time with them and make sure that I give them the due diligence, because they're trying to do this for me, after all...I think the respect thing of these are going to be my professors, and-- these videos I know are very time-consuming to make. You to do a lot of planning and videoing. It's not just professor. It's the staff that's helping them make them, I'm sure. And so yeah, I think that did have-- that was important. Int 4, [00:20:42.09]

- I: Did the fact that your professors were teaching it, did that have any effect on you?
  R: Oh, yeah, definitely. I think if it had been someone not affiliated with HMS, I probably would have been way less likely to do it. Because I think, one, it showed institutional buy-in, and it already gave me a sense of the quality of the teaching that was going on.
  I: So quality and buy-in.
  R: Mhm. Int 13, [00:34:02.57]

- I: How about the fact that it was online through videos, as opposed to, let's say, they handed you a handbook or a PDF of all the material. What was the effect that it was online?
  R: I think it made me think that it was, like, a bigger deal for the school, because I know that-- well, I don't know, but I imagine that it takes a lot of resources to put together a really good instructional video. So almost just wanting to me HMX halfway-- kind of thing. And they also showed a level of effort from your end. I mean, I had never really learned through videos before so interested in seeing what that was like. And PDFs can be a bit boring, or, like, very passive where you can just scroll through and think you're getting the gist of it. Int 13, [00:37:28.64]

8 Pioneering

- I: What was your kind of first impression when you got the email from HMX telling you about this program?
  R: I was excited to try it out mostly from a curiosity perspective to see what HMX is trying to do with online constant. And in general, I've been trying out different online content websites just to see an idea of the world, especially since I'll be in academia for the rest of my life.
  I: [LAUGHTER]
  R: So I'll probably be interacting with one of these platforms at some point. Int 10, [00:32:03.21]

- R: It was the first time they had launched something like that. So it's fun to be pioneering through something. Int 6, [00:19:34.58]

- I: Let's say if you got an email from HMX saying hey, Stanford came out with this module. It may be a good idea to check it out. Would you have?
  R: I think I would have, but I think I would have prioritize it less over if they said, we have this new thing we want you to try.
  I: So you think that a lot of it had to do with the novelty for it. Sorry. Your audio went out for a second.
  R: I think that it was a component. Yeah. Sorry. And I said certainly novelty was a component. I think that's part of why a lot of people ended up with the new curriculum here in general-- maybe that's why. That's speculation. Yeah. So yes. Some of it's not
novelty. Int 6, [00:35:27.39]

- R: I think in some of the anatomy stuff we've seen not in HMX but in our current courses, it's brand new. And we've looked at other materials from other schools that are very no name that I think are better. So I don't think that it was like a Harvard thing that made me want to do it. I think again, part of being a good learner or a good citizen-- kind of a cliché phrase-- part of putting out your best effort as giving a shot and giving honest feedback on a product that they're clearly very adamant about improving I think that was a motivation. So hopefully next year they'll have HMX 2.0 or whatever and it's more engaging and better. I think one of my improvement comments for the entire thing is I think they could include a lot more material. And I think there would be people that would be motivated about be doing a lot more. Int 6, [00:34:27.32]

- I: How about the fact that HMS was the one that put this out, that it was going to be your school, as opposed to, let's say, Stanford, or Georgia Tech, or somebody else who put this material up?
  R: Yeah, oh, definitely. I think that was a huge deciding factor. I was just impressed with the school and motivated to do it, because I felt like a part of the community putting it out.
  I: Right. And, again, is it a quality issue, or is it, again, the fact that this is your school? Besides the fact that it's Harvard.
  R: I guess mostly the fact that it is Harvard. Like, I'm sure Stanford would put out an amazing video series, as well, but I wouldn't necessarily feel as compelled or obligated to take part in it...One, I think, also, because I realized that you guys were looking for feedback. And you want feedback from HMS students so that was also another reason. Int 13, [00:34:37.08]

9 Curiosity

- I: How about if it was something in your wheelhouse? Let's say it was just chemistry.
  R: Just chemistry-- I probably would have checked it out, out of curiosity, but I would have had to feel like I'm getting something out of it-- Int 13, [00:37:01.18]

- R: I was curious how you would structure a medical course as an online course, especially since there are certain parts in medicine where I thought like, you know, histology and things where when I did pathology at HMS, I really appreciated the hands-on things I did. And I was curious to see how such things could be in a course that's online, so I wanted to see, what would they focus on? And what are the gaps that you would not glean from an online medical course? Int 10, [00:33:26.49]

- I: What was your kind of first impression when you got the email from HMX telling you about this program?
  R: I was excited to try it out mostly from a curiosity perspective to see what HMX is trying to do with online constant. And in general, I've been trying out different online content websites just to see an idea of the world, especially since I'll be in academia for the rest of my life...So I'll probably be interacting with one of these platforms at some point. Int 10, [00:32:03.21]

- R: I also was curious to see what it was like. I was curious to see if this is going to be like what class is like. What is it, exactly? And what is the curriculum going to be like when I start? That was definitely a really appealing aspect of doing it. Int 4, [00:10:54.30]
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<th>10</th>
<th><strong>Opportunity</strong></th>
<th>Interviewee described taking advantage of the opportunity to undertake the coursework.</th>
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<td>R: You know although I want to spend time with my family, my parents work, and my brother's at camp, so I'm going to need something to do with my time when people aren't around. So the initial I'm back to school sooner than I had anticipated went away fairly quickly because then I thought, this is actually a really great opportunity. Int 11, [00:26:32.64]</td>
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<th>11</th>
<th><strong>Sense of Obligation</strong></th>
<th>Interviewee described the implicit sense of the material being required.</th>
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<td>R: wow, they're already giving us stuff to do and we're not even there yet. I don't know. I know it's optional, but come on, this is Harvard. There's nothing optional. Let's be honest here. And so there was a little bit of that pressure to get this done. Int 1, [00:33:29.50]</td>
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<td>R: No. It didn't say it was required. I think I just assumed that it was. But it never explicitly said it was required Int 3, [00:31:01.98]</td>
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<td>R: I was under the impression, as I said, that this is something that was expected of us, and that we were asked to do. You don't really want to start med school behind. Int 4, [00:23:26.75]</td>
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<td>R: For me, when I'm asked to do something, I will do it, generally. Int 4, [00:11:15.67]</td>
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<td>R: I don't really think I felt it was optional...And so I don't know. At this level, I feel like nothing at least in my mind-- and not everyone sees it this way and I appreciate that-- optional means you should do it. Int 11, [00:27:06.61]</td>
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<td>R: I guess my motivation was that I didn't realize it was optional at the beginning. I thought it was a thing that everyone was doing. I'm not upset by that, but that was actually my initial [thought]. It was more like I need to do it, not like I wanted doing this. Int 13, [00:25:29.74]</td>
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<td>R: Even though it was voluntary, which I thought was great, it didn't feel voluntary for the most part. It felt like it was something that's &quot;voluntary&quot; in quotation marks, and that everyone would do it anyways or would ultimately have to do it to stay up to speed. Int 7, [00:22:15.56]</td>
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Research Question 2: *What self-reported factors and design elements contributed to student persistence in the optional online coursework?*

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<th>No.</th>
<th>Interviewee</th>
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<td>1</td>
<td>Early Clinician</td>
<td>Interviewee described enjoyment from getting early exposure to patients and seeing basic science principles applied to patient care.</td>
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<td>● R: I really like the clinical consideration videos. I don't necessarily think I got a ton out of it in terms of the science content, but it was a good add on and it was something that I was like, I definitely want to watch these. And I'm trying to think of other-- the animations were I thought pretty good in terms of the immunology videos and the different pictures of the cells. I: And you said specifically that you don't feel like you got much from the science content. Do you think, was it because of the level of the discussion, how fast it was discussed, or you didn't see the leap from the basic to the more applied? Or, what was it? R: So yeah. Specifically from the clinical videos, I feel like I didn't get any additional science content than compared to the rest of the videos because I think they were-- they definitely emphasized the same basic contents that we had been over earlier in the other videos. Yeah. Even despite that, I still wanted to watch them. I'm trying to think. I guess there were some-- like you know, this is an extra. This is how it is applied in the clinical context. But it wasn't something that I couldn't have learned just by like reading, oh, this is how we apply it. But I like the clinical videos just for actual seeing a patient and actually getting to hear how it affects their life, et cetera, et cetera. I: And do you think that having those clinical considerations kind of increased your curiosity for how it is applied in the clinical setting? R: Definitely. Yeah. It was cool to see these basic concepts applied because I feel like a lot of what you learn in these sorts of things you're like oh, I'm never going to remember this. I'm never going to need this. But actually having a video of them using this in the clinic was definitely a make it stick.</td>
<td>Int 5, [00:20:34.00]</td>
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<td>● R: It can be complicated, but they did a really good job of balancing the videos, and also with the kind of modules. I'm trying to think of what-- the memorable one is the scuba diver. I don't remember what the right term is, but a scuba diver. I: Scenario. R: So that was definitely a memorable one. And I think it was great to have it relate. I really liked how they related it to clinical aspects of medicine, and feeling like I actually care about what's happening to this scuba diver, because it's something that I might actually have to treat, instead of just having it be-- on our premed curriculum it was like, learn about partial pressures. Why do I care? And now it feels like they did a great with making it seem relevant.</td>
<td>Int 4, [00:06:57.23]</td>
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<td>● I: how about the physiology component? What made you want to do that, because I assume you've had some physiology in the past? R: I have had some. I guess my physiology back-- I thought the physiology-- I guess I didn't realize that it would be so much like some concepts from general chemistry. And so I just tried it out. And then I guess I liked completing the lessons. I liked hearing the clinical considerations once I tried one of them. So I was like oh, I'll keep doing this. And it was kind of, oh, I'm here.</td>
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I might as well finish the whole thing. Int 5, [00:15:22.08]

- R: I found more-- I really like problem sets and things like that, which I guess lends my effort to engineering stuff too. But I really like being presented a problem and given the opportunity to struggle with it for a while and come up with kind of creative ways to solve it. Again, in an engineering context, you can play with Matlab or Mathematica or something and try to come up with a coding solution or something. I really like that as a way of coming to my own understanding of the material. Med school is a little bit different, obviously, because at this point just a little bit more memorization of terms and pathways and things like that. And so I've really enjoyed clinical application stuff we've had in our materials I found really interesting and engaging more so that just kind of here's seven proteins that interact in a cascade and do whatever and you don't really know why. Having some context and not kind of learning things in a vacuum has been really motivational. But I mean, at this point everything is so new that it's just exciting to be studying things that I want to study. So ask me again in four months. Int 6, [00:06:25.47]

- I: Did the subject matter as to whether you signed in and decided to do the course?
  R: I think if it had been again there's an excitement like actually talking about medically pertinent material when you're branded and you're no loner going to be pre-med. You're going to be a med student now. I think there's-- it was exciting to look at the HMS email comes across and that kind of fancy graphics on it. I don't know. I thought it was engaging just to think about like physiology. You kind of scroll through the syllabus and saw that there were [INAUDIBLE] or dialysis or whatever. I think especially having not even stepped foot in medical school yet, that was engaging more so than if I'd been something I looked at before. That idea. Int 6, [00:22:18.25]

- R: And then immunology-- so then I did immunology. And I did not find it as user friendly. I guess the interface was fine, exactly the same. But I thought that it was much more of a dry lecture course that you were just watching. It was confusing. I thought it was much more confusing than physiology. I thought there weren't-- maybe it's harder. But there weren't as many examples or cool clinical correlations, whereas in the physiology I know there were visits to the pulmonary function lab. And then in immunology, I can't remember. But I don't remember seeing some sort of direct patient interaction or clinical correlation, which is something I'm always looking for. Int 7, [00:20:38.71]

- I: And you mention real life problems. Was that a really big thing for you in motivating you to participate and enjoy class?
  R: Definitely. I think a lot of times, especially with math, you can get lost in just plugging in numbers to equations. I think for me to see what these equations could actually mean even if in our context it is just you want to learn how to do the basics and manipulate the equations. I think-- we just finished a statistics course here. I'm in the HST program. So we haven't really started the I guess core medical courses yet. But a lot of times in the statistics course, I think the medical underpinning has got lost because we were just focused on equations. And I think that's kind of the complete opposite to how I felt in this course, where it was a lot of math. But at the same time, he would set it in a context where you could imagine it being applied to a real-world problem. Int 11, [00:07:51.71]

- R: I think just in terms of applying principles to patient cases, in the case of physiology, because I never really thought about problems in that way before. And so I guess the deficit would be thinking about problems in a very unrealistic way and just like
test problems where they just tell you numbers and they tell you have to this much is this much air is in the lungs and blah blah blah, and you do some calculations, but you're not really focused on what that means. And then to actually see how that information is used in the client, to maybe alter treatments or that sort of thing. I think making those sorts of connections was probably a deficit that I didn't realize. Because I never had to apply information like that. It's hard to say in terms of the other subjects because immunology like the terms and everything were coming back to me because I had obviously seen some of it before, but I don't know if there's like a really strong deficit that I realized as I was doing it. Int 11, [00:22:10.79]

- I: You said, you probably feel that your immunology knowledge was a big motivating factor. How much your physiology knowledge? You felt that you're relatively confident in your physiology, yet you still ended up going through that course work. So what was it about the physiology course work?
R: I actually enjoyed that one much more. Because that one showed me how these topics are being applied in real life. And so I think these scenarios were really nice. Because I didn't feel like I was just learning concepts and using equations, I could kind of see how the equations were relevant and used to understand the bends and people with different breathing issues and that sort of thing. So again, I guess it wasn't necessarily the information, in that case, that I was super keen on going after. It was the exposure to the clinical side of the information that I thought I knew a little bit already. Int 11, [00:28:59.91]

- I: After going through the HMS were you more or less nervous about starting? Without knowing what it's going to entail.
R: Yeah. I know. I know. It's hard to say. But I guess was definitely not more nervous. I guess maybe a little bit less nervous just because the professor seemed really cool. And that we actually were going to be applying this knowledge. And I guess it's not really-- in terms of less nervous more excited too at the same time. Which sometimes when you're nervous you can't be as excited because you're just fearing something. So I guess I was more excited. I think I'm still nervous. I don't know. It's hard. Int 11, [00:24:03.21]

- R: I personally felt the physiology course was done much better than the immunology course just because I would have liked to have seen more applications to the clinic. Because at least for me-- I don't want to speak for others-- but I think a lot of us are here because we want to make these connections between the science and people and helping people. And so especially coming into medical school, to have one of these summer courses already be bringing me into the hospital. I thought that was really neat. The immunology course felt more like a course I've already-- not that I've taking immunology-- but like my other courses that I have taken where you don't really make that connection. And I think that's something I'm very excited about being in medical school is to have patients come to the classroom and to hear from them what it's like to live with different diseases. And how what I am learning could help them. I think that's certainly something that is very important to me. Int 11, [00:43:34.13]

- R: Physiology I really enjoyed. I sat down with my dad and like led him through the diver one...I mean, it's very physics heavy and it's also very relevant to walking around, living. So I really enjoyed doing physiology. Like the kidney. My dad had never seen one of those and he's a PA. So he was like, Whoa. This is so cool I never knew what a dialysis kidney looked like. Int 12, [00:26:26.08]
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| 1 | I: What kinds of things were most memorable from our platform? Either because they were really good or they were really bad.  
R: Yeah. I just really enjoyed the physiology format. Going through some specific case and then being able to remember that case. I mean I can still-- you know the pastrami sandwich, the diver, the kidney, visiting the patient in ICU. Seeing the percent the oxygen and then knowing why it has to be higher than hemispheric. I just thought that it helps solidify concepts that have those specific examples and then explain the processes underlying the macro effects that we see.   | Int 12, [00:35:37.10] |
| 2 | **High ROI** | Interviewee described benefit to the undertaking the coursework and that facilitated persistence through the material |
|   | I: What kind of feeling did you get that made you want to sit down and basically do more work on the platform?  
R: Probably, again, intimidation. That was probably the main thing. But I think also once I found the first lesson so helpful, so it like also made me come back. (Int 2, [00:43:21.89]) |   |
| 3 | **Enjoyment** | Interviewee described a general sense of enjoying the platform and specific design elements that led them to enjoy the coursework. |
|   | R: I found it interesting. I found it engaging and didn't dread doing it. It was kind of fun. Int 4, [00:11:15.67]   |
|   | R: I think if I'd known it was optional, I probably would have done it just because it was interesting, and I actually did have a bit of time to do it. Int 13, [00:28:04.53]   |
|   | R: Two weeks before I came back I started looking at it. I was was like, oh this is kind of fun. Going through the videos were nice-- the little questions. Int 14, [00:21:55.00]   |
|   | I: pretend that I'm one of your friends, and I don't want to do it. What kinds of things would you tell me? Since you are in support of it, what kinds of things would you say?  
R: I would say that it's fun, and it's clinically relevant, and it will help give you a sense of the type of stuff you'll be doing once you're in school. So starting to learn now how to navigate that material and take notes on it, and how to learn from that type of video and reading or whatever. And how it's different than things you've done before, so getting experiences with it before you start would be a good idea. Int 4, [00:39:00.73]   |
|   | R: I did like was the quality of the videos. I thought that was, like, really impressive, and it made me want to watch the rest of them so that was good. Int 13, [00:43:52.25]   |
|   | I: What elements of the platform do you think were most conducive to your learning?  
R: I think the videos, just having like the audio and the visual come together with like, [instructor name]’s team trying things out and pointing to things. And being able to watch things at a higher speed for when I felt like I was really comfortable with certain   |
things-- that was helpful, too. Int 13, [00:45:20.18]

- I: Let's say that the logistics were taken out. That your technological issues were taken out. Do you think you would have done more of the platform?
  R: Yeah. I think I would have done more of it. Yeah.
  I: And what would have kept you going?
  R: Just how satisfying it was to go like, you just go through-- you get little questions. It's all in sequence. So it's very easy. I don't have to think about things. I don't have to open up different windows or take notes. It's all there. That was very nice. And to move directly from a nice, well put together video, to one question right afterwards. So I can use my short term memory, but also confirm it. And then discuss whatever-- that was good.
  I: So sort of the immediate feedback.
  R: Yeah. The immediate feedback. And smooth working is so key. That it works smoothly. Int 14, [00:32:42.97]

- R: I loved it. I really, really liked the interface. I thought the first module, which I think was a scuba diver module, was just so well done. And I was just kind of wowed by the effort that had been put into designing it. Because I thought it was very clear. The example videos were clear. The instructional videos were short enough so that I was willing to sit through it. But it was concise. And for me, when I learn, I need concrete examples. And one of the things that I've often found in the basic sciences is I can't see it, I can't visualize, I can't connect with what's going on in the cells to really be able to understand what's happening, versus physically being able to picture or just picture it in my head. So the scuba diver example, I loved that. In physiology, there was another example, I think, with the cork and the champagne model, which I thought, again, was just a really neat way to illustrate the concept. Because everyone can visualize that or relate to that and know what's going on. So I just thought that the interface was great. And I really enjoyed the course. Int 1, [00:35:21.89]

4 Need for Closure

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<th>Interviewee described a need to finish what they start.</th>
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<td>R: For me, when I'm asked to do something, I will do it, generally. Int 4, [00:11:15.67]</td>
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- I: What kept you going? You signed in, you saw what it was. What kept you going?
  R: Well, I like to finish the things I start. That's part of it. A little of anal retentiveness, you've got to make sure it's all done start to finish.
  I: You like the green checkmarks.
  R: Yeah. In fact, I just logged into it just a little while ago to make sure I-- in my mind that it still says, In Progress, because they keep it open so you can go back to refer to it. In progress? What did I miss? Do I need to go back? Did I forget to answer a question? What's going on here? So that's certainly part of it. I found it interesting as well. It was nice. Int 1, [00:35:21.89]

- I: how about the physiology component? What made you want to do that, because I assume you've had some physiology in the past?
  R: I have had some. I guess my physiology back-- I thought the physiology-- I guess I didn't realize that it would be so much like some concepts from general chemistry. And so I just tried it out. And then I guess I liked completing the lessons. I liked
## Media Effect

**Interviewee described multimedia elements of the platform that made it attractive and interactive.**

- **I:** Let's say it was your professors, and they gave you a handbook to read instead of it being online interactive.
  
  **R:** Hmm. Gosh, that's hard to say. I don't really quite know how to answer that. Not something I'd really thought about. Again, I probably would've worked my way through it. I liked having the media in some respects because of the way they were able to sort of break things up. But gosh, if it had just been straight reading, I don't know, I probably still would have done it. But it was kind of neat to do it online. There's kind of a cool guy factor there. So it is kind of fun to sort of show it off to people, like, look what I've got...there is something to be said for the media effect. Int 1, [00:39:12.93]

- **R:** The material was very good quality. There was no doubt about that. The videos were wonderful. The bit of written material that there was was fine. I think it was a very good quality. If it had been sort of slap dash, I don't think I would have stuck with it. If you're not going to bother putting time into it, then I'm not going to bother putting time into it. But yeah. I thought it helped. I thought it was quite nice. Int 1, [00:42:35.14]

- **I:** What was it specifically about the online aspect of this material that made you want to study it?
  
  **R:** I think one thing was definitely the interactive multimedia pieces which you can't really get in a classroom. And then another is that while in a classroom, you can't draw along with something you're explaining in biology. Int 2, [00:46:48.93]

- **R:** So I think having it be a day to day experience that you can imagine doing, or have done. I've been scuba diving. But also having-- as you're watching the scuba diver, you see next to it the-- I'm trying to remember how you saw the graph of partial pressure changing as your distance below the water changed, and that was definitely really helpful. I really liked getting to feel like, oh, this is something I conceptually understand, while also-- scuba diving is something you understand, while also seeing how the science relates to that on real time. Instead of seeing the scuba diver video, then going to see the graph later, having them up next to each other was one of the really good things about it. Int 4, [00:07:42.29]

- **R:** I think the scuba diver situation interactive scenario really stuck with me as one of the high points of the course. I thought
the ability to kind of drag around the diver depth-wise and watch different values change and things, I think that really helped, just kind of messing with it and playing around with it helped me, help reinforce some ideas that I probably knew talking about, partial pressures and things like that, again, like Gen Chem in college and whatever that was, like 2005. But yeah. I think that my understanding of that even ties in with-- like I'm a certified diver. Like I probably should understand some of these things better. But yeah. I think it did reinforce like, what does it mean to have the partial pressure of oxygen change as you dive verses just total atmosphere pressure versus gauge pressure, all those things. I think especially in that kind of interactive module I think really were helpful.  Int 6, [00:25:17.15]

- R: I loved it. I really, really liked the interface. I thought the first module, which I think was a scuba diver module, was just so well done. And I was just kind of wowed by the effort that had been put into designing it. Because I thought it was very clear. The example videos were clear. The instructional videos were short enough so that I was willing to sit through it. But it was concise. And for me, when I learn, I need concrete examples. And one of the things that I've often found in the basic sciences is I can't see it, I can't visualize, I can't connect with what's going on in the cells to really be able to understand what's happening, versus physically being able to picture or just picture it in my head. So the scuba diver example, I loved that. In physiology, there was another example, I think, with the cork and the champagne model, which I thought, again, was just a really neat way to illustrate the concept. Because everyone can visualize that or relate to that and know what's going on. So I just thought that the interface was great. And I really enjoyed the course.  Int 7, [00:19:06.28]

- R: I just thought they-- everything was extremely well done. I mean, my only experience with an online platform I guess was with the Kaplan one, and that was very poorly done. But with this one, I just thought it was pretty remarkable. Everything was very well connected. The quality was there. Everything was consistent. Just the, I don't know, every single aspect just seemed to be done by a professional. It was really good.  Int 2, [00:21:58.00]