Motivation and Perceived Costs to Achievement in Advanced Engineering MOOCs: A Mixed Method Study of Advanced Engineering MOOC Learners' Motivation and Perceived Barriers*

MITCHELL ZIELINSKI and VICTORIA WEST
School of Aeronautics and Astronautics, Purdue University, 701 W Stadium Ave, West Lafayette, IN 47907, USA.
E-mail: mitchellwz@gmail.com, vwest@purdue.edu

HILLARY E. MERZDORF and KERRIE A. DOUGLAS
School of Engineering Education, Purdue University, Seng Liang Wang Hall, 516 Northwestern Ave., West Lafayette, IN 47906, USA.
E-mail: hmerzdor@purdue.edu, douglask@purdue.edu

PETER BERMEL
School of Electrical and Computer Engineering, Purdue University, Birck Nanotechnology Center, 1205 West State Street, West Lafayette, IN 47907, USA. E-mail: pbermel@ecn.purdue.edu

Given recent, rapid changes in engineering workplaces, massive open online courses, or MOOCs are a promising option for educating the workforce with new knowledge and skills. However, few take full advantage of these resources, in part because professional learners can have many constraints limiting their ability to fully participate. Our research uses an explanatory mixed-methods design to examine differences in learners' self-reported factors hindering their ability to succeed in a course, and their perceived outcomes of not finishing the course. We administered a pre-course survey in three advanced nanotechnology MOOCs to survey learners' motivation from an Expectancy–Value–Cost framework, resulting in 806 responses. Learners responded to the short version of the EVC scale, as well as two open-ended questions regarding barriers to engagement and perceived outcomes of failure in the course. Using the cost subscale, we grouped learners into the highest and lowest cost quartiles. In parallel, we developed codes and themes for the qualitative items via open coding and used themes to compare high-cost and low-cost learners on areas which affect their potential success and effects of failure. Both groups cited barriers of work, time, and personal commitments, with high-cost learners reporting these factors more often. They generally listed few consequences of not being successful, but an equal number of high-cost and low-cost learners wanted to retake the course if they failed. Professionals balance motivational costs from many areas when participating in courses, and advanced professional MOOCs must be accommodating if learners are to persist.

Keywords: motivation; MOOCs; barriers

1. Introduction

According to Deloitte's *2018 Global Human Capital Trends* report, 21st-century careers are characterized by a nontraditional path. Employees are expected to be trained with many interdisciplinary skills, and to flexibly adapt to rapid changes in the workplace [1]. As the modern landscape of industry and work continues to change, companies stress the importance of lifelong learning and continue to search for effective professional development and training tools. Learning is ongoing from a variety of resources, including free and open content from massive online open courses (MOOCs) [1]. To meet these needs, open online resources are an increasingly feasible choice for employees and organizations to readily access materials at little to no cost [2]. Educational resources that are more current and more widely accessible are one solution to maintaining opportunities for lifelong learning in the workforce [3]. Once limited to higher education, MOOCs are growing more prevalent in digital workplace learning [4]. In both worlds of industry and education, recognition of nontraditional learning is becoming more systematically recognized through credentialing and digital badges [5]. Professional learning through digital badges is useful at a basic level for evaluation, but also for recruitment and training employees within organizations [6]. Credentials are valued by employees enrolled in MOOCs for professional development and independent learning [7]. These courses are able to provide advanced content to large populations of learners, making them a flexible and inexpensive option for digital workplace learning.

MOOCs can be a tool for companies in fields that have a need to keep their workforce up to date with new knowledge and skills. In particular, the field

of engineering requires that professionals are constantly developing their ability to tackle 21st-century problems, in order to keep up with industry needs for employees who are trained in thinking and problem-solving beyond static knowledge and skills [8]. Corporate MOOCs may be existing open courses used for professional learning, or they may be developed within an organization for its employees in order to tailor content to specific contexts [7, 9, 10]. In a study of employer attitudes and knowledge of MOOCs [2], employers listed access to highly specialized content as one advantage of MOOCs for their employees. Advancements in changing workplaces such as engineering fields can cause textbooks and other traditional teaching materials to become out-of-date too rapidly to be useful. MOOCs can serve as an alternative tool for the dissemination of cutting-edge research to working engineers and scientists, as well as to students preparing to enter the workforce.

For companies using MOOCs for professional development and training, the issue of learner retention is a major concern. Despite being less expensive than many traditional professional development programs, MOOCs still represent an investment of time and resources. Companies want to ensure that their employees will benefit from completing their courses. Thus, uncertainty about quality, as well as dropouts potentially caused by isolation of learners and low commitment, may prevent adoption of MOOCs [10]. While researchers have criticized drop-out as a metric of evaluation in MOOC, it has been shown a high percentage of learners in advanced STEM MOOCs actually report intention to participate fully in the course, yet very few actually do [11]. Research on persistence in MOOCs often focuses on modelling or predicting persistence, without attempting to explain the reasons why learners choose to disengage.

There is limited research into the motivation for employees to enroll in MOOCs, and how those motivations are affected by personal costs of participating and persistence [12]. Personal cost refers to perceived effort and loss of opportunities; essentially cost is the set of trade-offs that one makes to pursue a given activity. Adult learners have many motivations for enrolling in MOOCs, depending on their goals and costs [13]. Learning for adults in the next two decades is described by Muñoz and colleagues [14] as globalized for a higher adult population. It will be driven by a value for specialized skills and constant updating of knowledge, a context in part facilitated by technological advances and open educational resources such as MOOCs. Their predictions highlight challenges for guidance, inclusiveness, unique learning goals, and external

recognition that arise from unstructured learning [14]. Karnouskos argues that corporate MOOCs can help employees develop innovation skills by providing them with a learning culture, specialized knowledge, communication skills, and low-cost technology [15]. Even though employers are often supportive of employees who wish to take MOOCs, adult learners face barriers to success from other sources besides work. Motivations of adult professional learners often include filling gaps in knowledge for their current work [16], but their intentions may not always directly translate to changes in practice [17]. Barriers to pursuing a professional MOOC will vary greatly across adult learners, and may not remain consistent over time.

The intentions and actions of MOOC learners do not consistently align, as learners affirm a course's value and their own willingness to participate, and yet do not act upon these attitudes. In order to develop MOOCs to be useful for professional learners and support them in meeting their learning goals, we must understand more about what motivates them to enroll and begin a course, and how they are able to persist through difficulties to achieve their goals. From a research perspective, engineering educators and MOOC experts wish to understand more about what motivates advanced and nontraditional learners to participate in MOOCs, as well as the long-term impact of learning [18]. A complete picture of learner motivation requires an understanding of not only what learners hope to gain from participating in the course, but also what obstacles they perceive in their path to success. This picture will also vary between different groups of students. Working engineers can be expected to place a very different value on the completion of a MOOC than the general population, but they may experience many of the same barriers that prevent other learners from fully participating, or even additional barriers. Learning more about the nature of these barriers should enable MOOC providers and employee sponsors to work toward their mitigation.

2. Literature review

2.1 Persistence in MOOCs

Since major course platforms such as Coursera and edX came onto the scene in 2012, the low completion rates observed in MOOCs have been a significant topic of discussion. Many studies have focused on modelling learner persistence for the purpose of predicting dropout. For example, a recent study by Greene et al. [19] used survival analysis to show that self-reported commitment to completing the course was the strongest predictor of persistence in a large MOOC. However, the utility of course completion

as a single metric for learning in MOOCs has been questioned for nearly as long as the existence of MOOCs. Findings from a systematic literature review of four years of studies on predicting learning and/or persistence in MOOCs found that the generalization and interpretability of results is limited by the lack of a single commonly-accepted analytical method or framework for studying learning in informal digital education settings [20]. Early MOOC research proposed that MOOC participants should not be viewed as a single group of learners who either complete or fail to complete a course, but as a group of distinct subpopulations with unique interaction patterns with course materials [21]. MOOC participants are more likely to define success in a MOOC as the achievement of personal learning goals than the completion of course requirements [22]. Rather than limiting persistence metrics to single beginning and end points of enrollment and completion, more complex indicators of participation could better capture learners' ongoing motivation as it varies by course activity.

2.2 Expectancy–value–cost theory

Previous approaches for predicting MOOC learner behavior have been limited to interpretations which only account for a part of the variance among learners. The Expectancy Value Cost (EVC) theory of motivation is an emerging model which extends the earlier Expectancy Value model [23] with the possibility of providing a more complete explanation of learner behavior. The original model included cost as a component of achievement value [24], while the EVC theory considers cost as an independent factor of motivation. The model proposes that motivation is composed of three separate factors: expectancy, value, and cost. Expectancy reflects the extent to which a learner believes that they can be successful at a task. Expectancy includes the two dimensions: *ability beliefs*, which describe what a learner believes they can do now, and *expectancy beliefs*, which describe what a learner thinks they will be able to do in the future. Value reflects the extent to which a learner believes that a task is worthwhile. Value includes three dimensions: *intrinsic value*, meaning the learner finds the activity inherently enjoyable, *utility value*, meaning the activity helps the learner achieve short or long-term goals, and *attainment value*, meaning the activity affirms an aspect of the learner's identity. Cost includes elements such as learners' perception of the time and effort required to be successful at an activity, the opportunity cost of missing out on other valued activities, and negative psychological or emotional states resulting from an activity.

In the Expectancy Value model, value encompasses both positive and negative contributors to motivation [23]. However, recent work has proposed that cost, which represents the negative aspects of engaging in an activity, should be considered as another factor, distinct from value. In the traditional sense, cost is seen as spending resources such as money, time, or opportunities. Flake et al. [24] investigated four dimensions of cost: task effort (e.g., "This class takes up too much time"), outside effort (e.g., "Because of all the other demands on my time, I don't have enough time for this class"), loss of valued alternatives (e.g., "Taking this class causes me to miss out on too many other things I care about"), and emotional cost (e.g., "This class is too stressful"). After testing these dimensions in an in-person undergraduate calculus that cost is an important factor in students' perception of tasks [24]. They also performed a factor analysis and concluded that cost is related to learning outcomes, independent of expectancy and value [24]. To measure motivation using the EVC model, Kosovich et al. [25] established a 10-item scale as predictive of academic success in K-12 settings. While the entire scale is used by this study, we focus on the dimension of cost for understanding learner motivation, given that cost is a relatively new dimension to the EVC model that may represent the highest source of variability of intentions and obstacles for MOOC learners [26].

2.3 Motivation studies in MOOCs

Learner behavior in MOOCs can be viewed as an expression of their motivation, based on the claim that traditional metrics such as course completion are inadequate for describing learning in MOOCs [27]. Motivation can be broadly defined as "the process whereby goal-directed activity is instigated and sustained" [28, p. 5]. However, various studies of motivation in MOOCs use the term to refer to different concepts. Many studies have used motivational theories of considered MOOC learner activity using motivational theories [29, 30, 31]. Some studies use "motivation" to refer to learners' intentions, such as their reasons for participating in a MOOC. Learners' reasons for enrolling in MOOCs can predict their behaviors, even when they do not align with instructor-defined goals [21]. A more recent survey of learners who completed a nanotechnology MOOC found that university-affiliated learners tended to enroll in the MOOC for reasons related to their education, while general participants were more focused on career benefits [32].

Other studies use psychological theories of motivation as a lens through which to understand differences in groups of students. For example, a study by Mihalec-Adkins et al. [33] using self-determination

theory to examine learners in STEM MOOCs found they reported consistently high levels of intrinsic motivation, but that extrinsic motivation tended to vary with employment status. Full-time students were found to have higher levels of extrinsic motivation than workers and unemployed individuals [33]. Interpreting motivation both as intentions and using psychological theory provides a useful perspective for examining MOOC learners. Previous work by our group surveyed learners' intentions for participating in a MOOC and assessed whether they were intrinsically or extrinsically motivated [34], but this study takes the next step of integrating motivations with intentions.

2.4 Research questions

In this study we address two research questions: (1) What are the distributions of learners' motivations in terms of expectancy, value, and cost of participating in highly technical advanced STEM MOOCs? and (2) How do learners of high and low costs vary in terms of perceived barriers to engaging with the course? We use the subscale of cost within the Expectancy Value Cost (EVC) model to investigate differences in learners' motivation, and examine how their threats to motivation vary between reported high and low cost. A holistic understanding of motivation that incorporates both interpretations could provide insight into why learners choose to participate in advanced STEM MOOCs in the face of obstacles.

3. Methods

3.1 Study design

Analyzing quantitative and qualitative data together using a mixed-methods approach can provide a better understanding of a research problem than could be achieved by studying each type individually [35]. We employed an explanatory mixed-methods research design, in which the quantitative and qualitative data were collected simulta-neously using the pre-course survey. We first analyzed the quantitative data, and used the results of the study to identify high- and low-cost learners from the variability among learners found by the cost subscale, then qualitatively analyzed each group's open-ended responses separately, in order to find differences in themes. Specifically, the quantitative phase of the study sought to address the first research question of our study by examining learner motivations. The results of this first phase contributed to answering our second research question of our study using qualitative investigation of obstacles to success and consequences of failure.

3.2 Participants and data collection

The pre-course survey consisted of demographic questions, questions about learning goals, intended use of the course, reasons for taking the course, and questions about motivation. Questions about motivation consisted of an EVC instrument modified from the scale developed by Kosovich et al. [25] and a number of related open-response questions (see Appendix). Pre-course surveys were administered as part of the first-week course material in three advanced nanotechnology MOOCS delivered on the edX platform, and 1151 learners responded to the survey. Of these respondents, we chose to limit our study to the 806 learners who had completed at least 50% of the survey. Reflecting the open nature of the three MOOCs studied, participants reported a wide range of ages and educational backgrounds. Complete demographic information can be found in Table 1.

3.3 Quantitative phase

The EVC instrument used to measure learner motivation consisted of ten multiple-choice questions that used a six-point Likert scale from 1 (Strongly Disagree) to 6 (Strongly Agree). Some of the wording of the EVC instrument was changed slightly from the original scale developed by Kosovich et al. [25] to fit the MOOC context, but the content of the

Table 1. Demographic Information (n = 806).

	n	%		n	%
Gender			Highest education level		
Female	204	25	Less than high school	10	1
Male	499	62	High school/GED	76	9
Prefer not to answer	12	2	Some college	55	7
No response provided	91	11	2-year college degree	39	5
Age			4-year college degree	228	28
Under 15 years	3	0	Master's degree	210	26
15 to 24 years	271	34	Doctoral degree	77	10
25 to 34 years	273	34	Professional degree	26	3
35 to 44 years	72	9	No response provided	85	11
45 to 54 years	55	7			
55 to 64 years	32	4			
65 to 74 years	8	1			
No response provided	92	11			

questions remained the same. High scores on the three questions that measure *expectancy* indicate that the learner feels capable of effectively completing the course and learning the material. High scores on the three questions that measure *value* indicate that the learner feels course material is important, valuable, or useful. High scores on the four questions that measure *cost* indicate that the learner feels they will be unable to engage fully with the course due to time constraints or other obstacles, external to the course itself. It is important to note that high scores on the expectancy and value items indicate a higher level of motivation, while for the cost items high scores actually indicate a lower level of motivation. In order to simplify analysis, we chose to work with averages of learners' EVC scores received on all of the questions for each of the three dimensions.

The EVC scale has demonstrated measurement invariance across gender, academic domain, and completion time. Reliability estimates, calculated using coefficient omega, have been shown to be $\alpha = 0.88$ for expectancy, $\alpha = 0.84$–0.88 for value, and $\alpha = 0.86$–0.87 for cost, depending on the academic domain [25]. We examined demographic differences between learners in the quartile with the highest average cost score and those in the quartile with the lowest average cost scores. Additionally, we performed Kruskal-Wallis one-way analysis of variance tests to determine the relationship between EVC instrument scores and demographic information.

3.4 Qualitative phase

The results of the quantitative phase lead us to focus on the open-ended questions related to the cost items on the EVC instrument. The two questions related to cost were "What factors in your life are most likely to hinder your ability to engage with or succeed in this course?" (Question 10) and "What would be the consequence if you fail to successfully complete this course?" (Question 11).

We employed methods from a phenomenological perspective [35] to learn which factors MOOC learners felt were preventing them from fully engaging in the course, and their perceived consequences of being unsuccessful in the course. We followed Patton's [36] guidelines for qualitative analysis by triangulating quantitative results of motivation with more in-depth data on learners' sources of cost and perceptions of failure. First, two authors explored all of the responses to the two selected questions, taking notes on potential themes. The themes and resulting codes for Questions 10 and 11 are summarized in Table 2. Next, the two authors compared notes and developed a large number of codes, representing a wide array of topics that were potentially relevant to the research question. These codes were applied to the distribution of cost responses from learners in the high and low quartiles. Some responses had multiple codes applied. Percentages of high- and low-cost learners for both questions are shown in Figs. 2 and 3. The responses were grouped by code and analyzed by the two authors, resulting in the distillation of the coding scheme to a much smaller set of themes that the authors felt best represented the ideas being expressed.
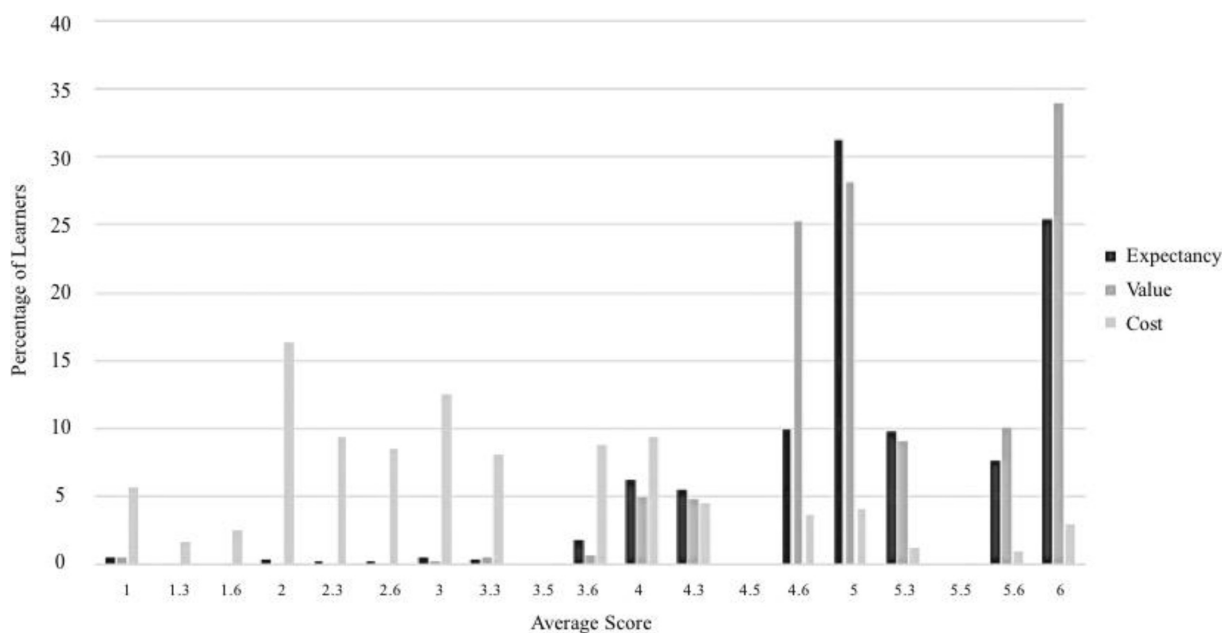

Fig. 1. Distribution of average EVC scores for all learners.

4. Results

4.1 Quantitative phase

The distribution of individual learners' average EVC scores in all three courses is displayed in Fig. 1. The vast majority of learners receive high average scores for the expectancy and value questions, indicating that they perceive the course as useful and themselves as being capable of success. The data is bimodal in each case, but both peaks are at values above 4.5 (out of 6). Significantly more variation is seen in learners' average cost scores by learners, with the distribution of responses tending towards low cost but including learners with high cost of participating.

After grouping the learners into quartiles based on their average cost scores, we compared the demographic information of learners in the quartiles with the highest and lowest average cost scores (both $n = 202$). The complete comparison is shown in Table 2. The learners in the high- and low-cost quartiles report slightly different demographic information. The balance of male and female learners leans more toward males in the low-cost quartile than in the high-cost quartile, with 67% male and 20% female for low-cost learners versus 60% male and 25% female for high-cost learners. Age skews somewhat older for the low-cost quartile than the high-cost quartile, with 5% more learners aged 55 to 64 years and 5% fewer learners aged 15 to 24 years in the low-cost quartile compared to the high-cost quartile. The reported education level of learners in the high- and low-cost quartiles is not significantly different, with no category differing by more than 2% between the two quartiles.

We performed Kruskal-Wallis one-way analysis of variance (ANOVA) to analyze the relationship between demographic information and average EVC scores. A statistically significant similarity exists between average expectancy score and gender ($p = 0.001$), and between country and employment status. No statistically significant similarities ($p < 0.05$) exist between average value or cost scores, and any of the reported demographic information.

4.2 Qualitative phase

Recurring themes in learners' open responses to the question "What factors in your life are most likely to hinder your ability to engage with or succeed in this course?" are summarized in Table 3. The hindering factors described by learners can be grouped into two major categories: external factors such as time commitments and access issues, and personal factors such as motivation or a lack of prerequisite knowledge. Additionally, many learners stated that they were unsure of what factors would hinder their ability to engage with the course or believed that there would be no obstacles to their success.

Recurring themes in learners' open responses to the question, "What would be the consequence if you fail to successfully complete this course?" are summarized in Table 4 and their codes. Many learners indicated that the course related to their career or their formal academic studies, and that failure to complete the course would negatively impact their success or advancement in those

Table 2. Demographic information by cost quartile ($n = 806$)

	High-Cost		Low-Cost	
Gender	n	%	n	%
Female	51	25	40	20
Male	122	60	136	67
Prefer not to answer	4	2	1	0.5
No response provided	25	12	25	12
Age				
Under 15 Years	1	0.5	0	0
15 to 24 years	68	34	58	29
25 to 34 years	66	33	71	35
35 to 44 years	2	11	22	11
45 to 54 years	11	5	11	5
55 to 64 years	5	2	14	7
65 to 74 years	2	1	3	1
No response provided	26	13	23	11
Highest education level				
Less than high school	2	1	1	0.5
High school/ GED	22	11	19	9
Some college	12	6	14	7
2-year college degree	11	5	12	6
4-year college degree	60	30	61	30
Masters degree	46	23	50	25
Doctoral degree	20	10	19	9
Professional degree	5	2	4	2
No response provided	24	12	22	11

Table 3. Themes for Question "What factors in your life are most likely to hinder your ability to engage with or succeed in this course?"

Theme	Theme Description	Codes	Sample Response
Fear	General apprehension towards course	Fear	". . . fear to lose mark"
Personal Commitments	Family and other specific scheduling conflicts	Family Misc Life Circumstances Schooling Work	"Some health issues I'm on dialysis 3x a week (affecting time devoted)" "My work time and family commitments" "My college schedule"
Finding Time	General busyness, or explicitly a lack of time available	Time	"Priority demands on my time" "The time to take the course, it could be a problem for me"
Lack of Necessary Knowledge Background	Lack of prerequisite knowledge, or inadequate language skills	Lack of Knowledge Language Late Start	"My knowledge in chemistry" "Lack of knowledge in English"
Internet Access	Lack of stable or consistent Internet access	Access	"May be due to limited internet provided by our [institution]"
Motivation	Lack of self-motivation or outside motivation to complete course	Motivation	"Procrastination and lack of motivation" "To be dedicated"
Unknown/None	Absence of barriers to success, or uncertainty of possible barriers	Unknown None	"Have not given much thought about it" "None I guess"
Other	Indiscernible response	Other	"Excellent in electronics"

Table 4. Themes for question "What would be the consequence if you fail to successfully complete this course?"

Theme	Theme Description	Code(s)	Sample Response
Career Impact	Potential harm to current career progress or future career prospects	Career Impact	"The course is significant to my career growth and development as such, I cannot afford to fail the course." "Continue working on a production line"
Academic Impact	Potential academic setbacks or harm	Academic Impact	"My PhD research won't have desired quality" "I wouldn't be able to keep working in my project and competition"
Disappointment in Self	Disappointment or other psychological consequence	Disappointment	"Personal dissatisfaction" "I would be disappointed in myself." "Some frustration and might lose confidence"
Relearn Material	Making another attempt to learn the material, potentially re-taking the course	Retake Review	"I will repeat it until success" "Return back later for the course materials" "I might redo it or look for it somewhere else"
Lost Opportunity	Course is seen as inherently valuable to the student, not completing would be missing out on the opportunity	Lost Money Lost Opportunity Wasted Time	"My money will go" "I will lose an extraordinary opportunity to learn more about biosensors" "Waste time"
Unknown/None	No consequences for failing to complete the course, or unknown consequences	None	"Nothing will happen to me" "I have no idea, I am so excited for the course, I just take for granted I will succeed in this course"
Other	Off-topic or indiscernible response given	Other	"Anyways this will be archived . . ."

areas. Other learners anticipated fewer concrete consequences of failure, such as knowing that they had missed an opportunity for learning or simply being disappointed by their lack of success in the course. Some learners stated that they were unsure of what the consequences would be for failure, or believed that there would be none.

For the question "What would be the consequence if you fail to successfully complete this course?", 40% of high-cost learners and 64.4% of
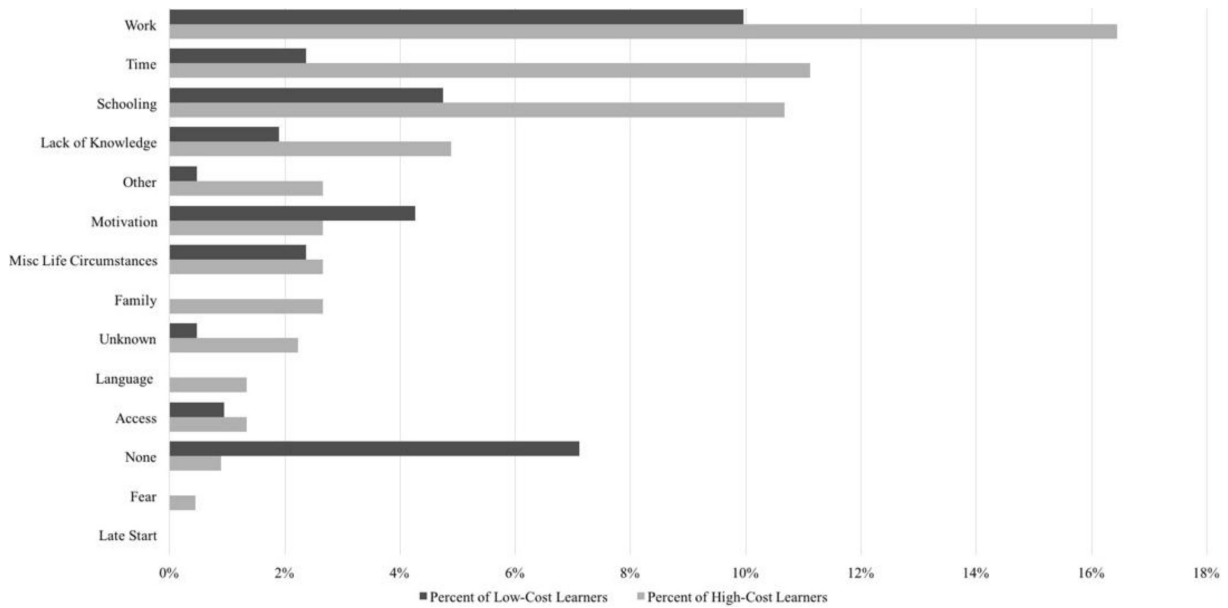
Fig. 2. Indicated obstacles to success for low-cost and high-cost learners.

low-cost learners did not respond. Of those who responded, both groups saw work commitments as the biggest hindrance. High-cost learners also included time and schooling constraints. Low-cost learners' second most common response was no obstacles, while only 1% of high-cost learners believed this. Very few learners of either cost group were unsure of possible barriers. In addition, low-cost learners did not anticipate that family hindrances, language barriers, or fear would keep them at all from engaging. Compared to high-cost learners who were primarily concerned with external factors, having the motivation to succeed was a greater anticipated challenge for low-cost learners. Figure 2 shows responses as percentages of high- and low-cost learners.

For this question, 44.75% of high-cost learners and 66.18% of low-cost learners did not respond. Both groups most strongly felt that failure would have no consequences. However, nearly twice as many high-cost learners expressed this belief as low-cost learners. An equal number of learners from both groups planned to retake the course should they fail. More low-cost learners than high-cost learners anticipated that failure would negatively impact their career. High-cost learners expressed more disappointment in themselves, fears of losing a valuable learning opportunity, and concerns regarding negative impacts on their academic career if they did not complete the course. Compared to external factors such as lost money and wasted time, the internal factors of losing opportu-
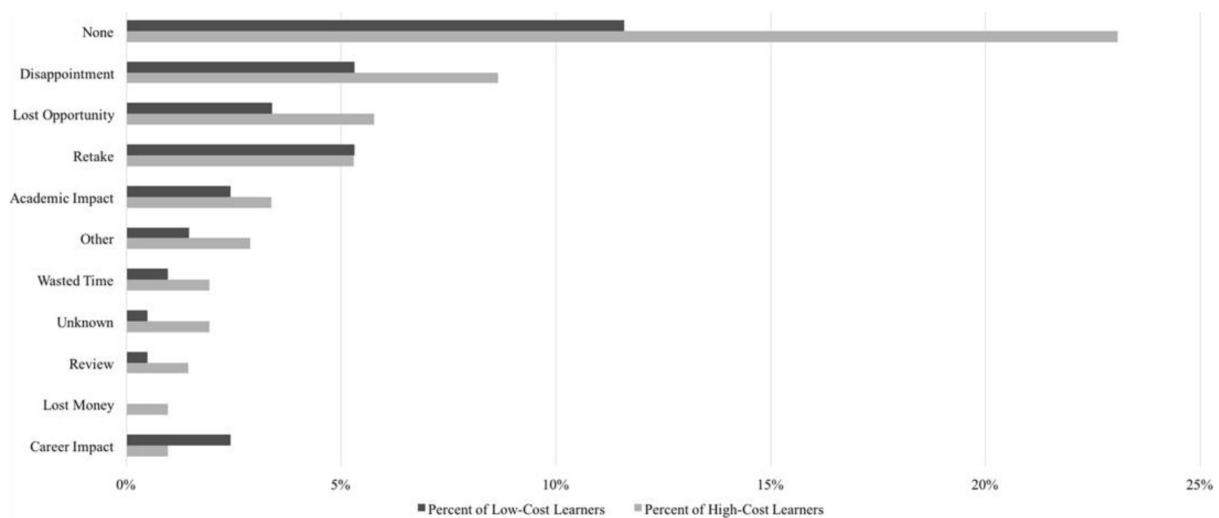

Fig. 3. Indicated consequences of failure for low-cost and high-cost learners.

nity and disappointment were of greater concern to both groups. Figure 3 shows percentages of high- and low-cost learners who responded.

5. Discussion

Most learners expect to do well in the course, even with many self-reported obstacles. Low- and high-cost learners both demonstrated resilience by sharing the same willingness to retake the course if they failed to successfully complete it. Because both groups of learners indicated high expectancy and value for the course as a whole, it was shown that learners who choose to take the course multiple times despite failure also intrinsically value its content. These attitudes give a promising depiction of professional learners who must be knowledgeable about cutting-edge skills and training [2] and adult learners who pursue topics that personally interest them [13]. However, barriers still exist that can prevent these learners from succeeding. There is a need for infrastructure changes where digital learning is more seamlessly integrated with everyday life, and this in part depends on the acceptance and recognition of MOOC training within professional settings [14]. Corporate MOOCs, and the supervisors who permit their employees to enroll, should foster persistence and achievement to make course completion and realization of learning objectives as straightforward as possible. Companies investing in the training of human capital at work will be willing to reduce short-term requirements to enable long-term employee development of potential. Because the idea of cost represents tradeoffs, companies must allow their employees to make these short-term tradeoffs, in order to work towards learning new material and skills. We do not assume that employees could be able to dedicate time and resources to a course with the same commitment as a full-time learner. Therefore, it is more feasible and productive to suggest that employers support professional learning by reducing external demands on employees. MOOCs are flexible in allowing employees to decide how much learning they will complete in a sitting. Conversation between employers and professionals is necessary to find how best to achieve balance between work and education. In this way, employees are more likely to achieve a balance between working and learning, with optimal performance on both.

The same freedom that contributes to motivation in some learners may also be a cause of low commitment in others, given many learners' strong beliefs that failure would have no consequences. High-cost learners more readily believed that there would be no negative outcomes of quitting, because the course is relatively low-stakes compared to their many other competing demands. Professionals enrolled in MOOCs are learning with the goal of improving their career [32], while simultaneously managing a career that takes time and resources away from their studies. Unlike traditional students, whose primary focus is on coursework with job and family duties coming second, adult learners must find ways to improve their skills that do not detract from their performance. External duties may take clear precedence over completing the course, such that learners would rather drop the course than lose control of other life responsibilities. If learners are to feel that advanced STEM MOOCs are important enough to complete, the course itself as well as employers must accommodate their individual learning practices and needs, while still meeting the course learning objectives. Greater flexibility in accessing the course, balancing work and course deadlines, and communicating with instructors and peers could all help significantly reduce high-cost learners' readiness to leave.

6. Limitations and future research

A limitation of our study is the observed ceiling effect of the EVC instrument. With learners responding very highly to the subscales of expectancy and value, these items were less discriminatory for different trait levels of motivation. This made the cost subscale the most sensitive of the three, and therefore the most descriptive of learners' true motivational states at the beginning of the course. In order for the EVC instrument to be useful for differentiating among MOOC learners at their true levels of expectancy and value, future research may wish to adjust for item-level ceiling effects using weighting or other techniques.

Given that our findings focus on anticipated behavior reported by learners on the pre-course survey, further study may continue to link intentions with other behavioral aspects of engagement and persistence. These behaviors are especially important in nontraditional and adult learners who often make up the population of MOOC learners. Once they begin a course, learners' motivations and planned actions will be changed, adapted, and disrupted by experiences both within and outside of the learning context. Further research is needed to create responsive MOOCs which will accommodate high-cost learners, by allowing their self-created goals and intentions to drive their course performance and activity rather than completion [13]. Responsive MOOCs will identify learners who need help before they leave a course, and will provide both learners and instructors with the resources they need to continue and succeed.

7. Conclusions

Understanding learner engagement in terms of motivation is a useful way of understanding their purposes and challenges to pursuing a MOOC course. Learners in MOOCs share high expectations for success when beginning a course, and value its content as a resource. However, they face many obstacles to their goals which threaten their ability to persevere. The EVC scale is useful for identifying learners with different degrees of cost to complete a course, but alone it does not describe their sources of engagement cost. When further surveyed to investigate barriers to success, MOOC learners listed challenges which varied by level of cost. For high-cost learners, their primary interference came from work, time, and schooling constraints, while low-cost learners also suggested low motivation or did not have barriers. Many learners also described the consequences of failure which affected their academic and career pursuits, opportunities, and opinions of self; still, the majority of both groups did not see any negative outcomes of dropping out. Differentiating responses by cost provides more detailed information about what types of challenges are faced by high- and low-cost learners.

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Appendix

Table 1

1	2	3	4	5	6
Strongly Disagree	*Disagree*	*Slightly Disagree*	*Slightly Agree*	*Agree*	*Strongly Agree*

E1	I know I can learn the material in this course.
E2	I believe I can be successful in this course.
E3	I am confident that I can understand the material in this course.
V1	I think this course is or will be important.
V2	I value this course.
V3	I think this course is or will be useful.
C1	Because of other things that I do, I do not expect to have time to put into this course.
C2	I think I will be unable to put in the time needed to do well in this course.
C3	I think I may have to give up too much to do well in this course.

Mitchell Zielinksi, at the time of writing, was researching evaluation in MOOCs while pursuing a master's degree at Purdue University's School of Aeronautics and Astronautics. After completing his degree, he now develops operations and analysis software for NASA's Earth Observing System missions.

Hillary E. Merzdorf is a Ph.D. student in the School of Engineering Education, and a Master's student in the School of Industrial Engineering, at Purdue University. Her background is in cognitive psychology, assessment, and research methods. Her research interests include evaluation of digital learning technologies, especially virtual and augmented reality, assessment in online engineering education, and the effective use of student data.

Victoria West is an undergraduate student in the School of Aeronautics and Astronautics at Purdue University, with a focus in structures and communication. Her research interests include the role of communication in engineering processes and methods for effectively teaching engineering concepts, as well as structural analysis and design of aircraft and spacecraft.

Peter Bermel is an associate professor of Electrical and Computer Engineering at Purdue University. His research and teaching focus on improving the performance of electronics using the principles of nanophotonics (i.e., the behavior of light at the nanoscale) — particularly in designing and characterizing novel materials and devices. His prior work includes understanding the role of optics in improving energy generation and energy efficiency, as well as characterizing learner behavior and outcomes in nanotechnology MOOCs.

Kerrie A. Douglas is an Assistant Professor of Engineering Education at Purdue University. Her research is focused on assessment design, methods of validation and fair assessment for diverse engineering learners. This focus includes what evidence and rationale are used to justify assessment use and the consequences of that intended use. She earned her PhD in Educational Psychology, with a concentration on evaluation and assessment, from Purdue University in 2012. She was awarded as a New Faculty Fellow in 2018 at the Frontiers in Education Conference.