

Empirical Research Paper

Measuring the motivational climate in an online course: A case study using an online survey tool to promote data-driven decisions

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ABSTRACT

Creating a positive motivational climate in an online course can engage students in their learning. Instructors may be able to better manage their courses and create a positive motivational climate if they implement online survey tools that allow them to assess the motivational climate of their courses. Teachers and researchers have documented that five student perceptions—empowerment, usefulness, success, interest, and caring—are particularly important for creating a positive motivational climate and are associated with students' engagement and evaluations of teaching. In this paper, we describe a case study of an instructor who used an online survey tool to assess the motivational climate in his online asynchronous course over time. He then used the feedback to consider improvements that he could make to his course in the future. In addition, we describe how this process of using the online survey tool could be used by instructors to transform education.

1. Introduction

The digitization of teaching and learning has increased in recent years (Allen and Seaman, 2016), and this trend has created a variety of challenges for instructors who are new to digital education. For example, higher education instructors are challenged with motivating students in online courses offered asynchronously. Asynchronous online courses typically do not provide the means for instructors to talk to students or observe their non-verbal behavior, which limits the feedback that instructors receive from students about their motivation in the course. Instead, online instructors are reliant on students' responses to assignments and interpersonal communications (e.g., emails) to judge their motivation. Understanding students' levels of motivation during a course can be helpful to instructors because it allows teachers to adjust instruction or provide feedback that can keep students motivated to reach their learning goals. In other words, instructors might be able to better manage their courses if they had tools that would allow them to assess students' motivation and had strategies to address deficits in the motivational climate of the course.

Unfortunately, many instructors lack the tools and strategies needed to effectively manage an online course because they lack experience with digital education and are unfamiliar with motivation strategies that they could employ (Jaschik and Lederman, 2019). Creating a positive

motivational climate in courses is important because it has been shown to be related to increased student effort and higher course ratings (Chittum et al., 2019; Jones, 2010, 2019; Jones and Carter, 2019; Jones and Skaggs, 2016; Jones et al., 2014, 2017, Jones et al., 2019; Li et al., 2016; Wilkins et al., 2021). The *motivational climate* of a course refers to the aspects of the psychological environment that affect students' motivation and engagement within a course.

We examined the following question in this study: How can an instructor use data obtained from an online survey tool to assess the motivational climate in an online asynchronous course? The purposes of this study were to answer this question and to describe how this digital assessment process could transform education. To do so, we present a case study from an asynchronous online course in which students' motivation-related perceptions were assessed at several times throughout the course.

2. Theoretical frameworks

2.1. The MUSIC Model of Motivation Theory

The MUSIC Model of Motivation Theory (Jones, 2009, 2018, 2020) was developed from within the field of educational psychology to provide instructors with a framework to organize motivational teaching

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strategies. The theory is based on current psychological theories and divides motivational teaching strategies into five categories: eMpowerment, Usefulness, Success, Interest, and Caring (the initial sounds of the words form the acronym MUSIC). The *eMpowerment* strategies refer to those that provide students with some autonomy and control to make decisions within their learning environment. The *Usefulness* strategies include those that help students understand why what they are learning is useful for their short- or long-term goals. The *Success* component of the MUSIC model includes strategies that help students believe that they can succeed at activities if they put forth the effort required. The *Interest* component refers to strategies that interest students in the content and instructional activities, and the *Caring* strategies include those that improve the quality of relationships between the instructor and other students in the class or between students (Jones, 2018).

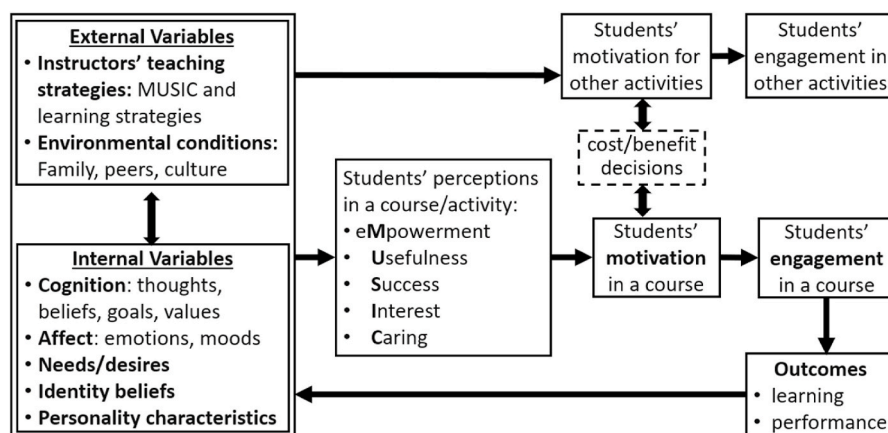
Instructors can use MUSIC strategies to affect students' MUSIC perceptions during a course or within a specific activity. Decades of research from a variety of motivation theories have documented that students' perceptions of empowerment (e.g., autonomy, Ryan and Deci, 2020), usefulness (e.g., utility value, Eccles and Wigfield, 2020), success (e.g., self-efficacy, Bandura, 1997), interest (e.g., situational interest, Renninger and Hidi, 2015), and caring (e.g., Wentzel, 1999) are related to their motivation and engagement. Fig. 1 shows how external variables (e.g., instructor's teaching strategies, environmental conditions) interact with students' internal variables (e.g., cognition, affect, needs/desires, identity beliefs, personality characteristics) to affect students' MUSIC perceptions during a course or activity, which then affects their motivation. Motivation is defined as a student's intent to engage in a course or activity (Jones, 2018). The model in Fig. 1 shows that motivation precedes engagement such that students who are motivated have not engaged in the course activities, but they intend to, at least to some extent. Before deciding if they will engage, students consider the costs and benefits of engaging in the course versus engaging in other activities. The extent to which students engage in courses affects outcomes such as learning and performance. Students who are highly engaged are more likely to learn more. These outcomes then cycle back and affect the external and internal variables. This cycle can occur fairly quickly, because as soon as an outcome occurs, it can affect the external and internal variables. As an example, consider students who complete an online quiz and immediately receive a grade because the quiz is graded automatically through the online learning management system.

Students who receive a low grade may become upset and believe that they have a low ability, which can lower their perceptions of success and lower their motivation to engage in the next course assignment or quiz. Or, for students who believe that they can succeed despite their low grade, the low grade could cause the student to work harder to demonstrate their ability. Because outcomes such as quiz scores and assignment grades can affect the external and internal variables, it is possible for students' motivation and engagement to change throughout the duration of a course.

We used the MUSIC Model of Motivation theory as our conceptual framework for this study for several reasons. First, the five MUSIC perceptions at the center of the theory cover a broad spectrum of student course perceptions that have been studied by motivation researchers. Most other motivation theories do not include the breadth of perceptions that are directly related to the motivational climate in a course (Jones et al., in press). Second, the five MUSIC perceptions relate directly to categories of teaching strategies; therefore, after instructors identify which perceptions are lowest, they can make plans to implement changes to their motivational teaching strategies. Third, the MUSIC model explicitly depicts students' motivational perceptions within a cycle of factors that can affect their course perceptions over time. Using a cyclical model was especially important in the present study because our aim was to assess the extent to which students' perceptions changed over time.

Some longitudinal studies have investigated students' motivation-related perceptions within a course over time. Those studies have typically focused on changes in one or more motivation-related variables. For example, Sotak et al. (2021) examined the weekly patterns of undergraduate students' mood over eight weeks. In another study, Choudhury (2019) investigated the days when the attendance of college students was lowest in a week throughout a semester and analyzed the effects of those missed days on student performance. Ouweneel et al. (2013) examined the effects of changes in students' self-efficacy and engagement over two time points during a semester. Other researchers have examined multiple motivation-related constructs, such as (a) effort, competence, and autonomy over a week (Malmberg and Martin, 2019) or (b) expectancies, values, and costs over a semester (Dietrich et al., 2019).

Although these types of studies have analyzed the changes in certain motivation-related constructs over time, researchers have not



Note. The MUSIC Model of Motivation connects variables external and internal to the student, to students' course perceptions, motivation, cost/benefit decisions, engagement, and outcomes. Adapted from "Motivating Students by Design: Practical Strategies for Professors," by B. D. Jones, 2018, p. 13.

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Fig. 1. Theoretical Relationships Between Variables in the MUSIC Model of Motivation

systematically studied changes in all five MUSIC perceptions over three or more time points during an online course. Including all five MUSIC perceptions (as opposed to only one or two) in the feedback to instructors could provide a more complete view of students' course perceptions and the motivational climate in the course. Furthermore, assessing these perceptions at three or more times during a course would allow the instructor to assess possible changes that may occur over time, or in response to specific instructional activities. To address these needs, in the present study we assessed all of the MUSIC perceptions at five times during an online course. Analyzing these data required us to examine students' course perceptions over time as a complex system, as described in the following section.

2.2. Complex dynamic systems theory

Complex Dynamic Systems (CDS) theory is a scientific approach for investigating a variety of complex systems (Garner and Kaplan, 2021). Complexity of systems arises from complex, reciprocal, and nonlinear interactions among interdependent components that comprise the whole system (Davis and Sumara, 1997). Complex systems are also dynamic because such complex interactions among system components result in emergent outcomes and changes in system behavior over time as a self-regulating response to the changing conditions of the environment; the system behavior is in a continuous state of self-regulation and emergence, and in constant movement over time (Hilpert and Marchand, 2018; Kaplan and Garner, 2017). Therefore, the emergent system behavior cannot be reduced to the individual components of the whole system. In other words, unlike causal models in which a linear arrangement of components sums up to produce the behavior, the complex system components do not simply add up their characteristics to produce the emergent system behavior (Hilpert and Marchand, 2018; Holland, 2006). Consequently, complex systems need to be investigated as a whole rather than studying only the causal linear relationships among the components within the system. A change in any one component will affect the entire system and the outcomes (Kaplan and Garner, 2017).

The complex and nonlinear interactions among the system components in complex systems lead to outcomes that tend to be less predictable than noncomplex systems in which those outcomes can be explained by linear cause and effect relationships (Garner and Kaplan, 2021; Kaplan and Garner, 2017). When internal or external perturbations occur in the environment, the system behavior responds to meet the demands of the conditions, and a positive change in one of the components interacts positively with other components. As a result, the dynamic of the system tends to frequently return to a more stable *attractor* state where stability and equilibrium are maintained through system reconfiguration and self-regulation (Kaplan and Garner, 2017). Geveke et al. (2017) explain attractor states with a fly metaphor within the context of a room. A fly (as a complex system) may randomly fly around the room with no intention to arrive at a particular place. Or, an external force such as a flycatcher may determine where in the room the fly will position itself. However, any complex system will strive to move to a particular state and remain there while it resists external variables that force it to move. If an external force chases the fly away, it will try to fly back to this particular place. These particular places that the system tries to move towards and remain for a period of time are called attractors. The system tends to stay in an attractor state until an activation in one of the components can trigger other components, which causes disequilibrium and tension within the system. When this is the case, the system demonstrates high behavior variability, which is called a *repellor* state, and the system stays in this state until it returns to an attractor state in which it can maintain stability (de Ruiter et al., 2018; Koopmans, 2020). Therefore, systems have a tendency to move away from repellors and return to an attractor state through self-regulation (Kunnen and van Geert, 2012). Overall, system components are in a state of a continuous interaction affecting one another positively or

negatively against perturbations received from the environment, and they self-regulate to ease back to stability and equilibrium (attractor state) and move away from instability and disequilibrium (repellor state) to maintain the emergence of further stability through adaptation and resilience.

Another characteristic of complex system behavior is that it is susceptible to initial conditions. Initial conditions refer to "how the system is set up through its many variables as it commences the activity" (Poupore, 2018, p. 353). One example of initial conditions within an educational context would be the type and presentation of a learning activity (described as "External Variables" in Fig. 1) and students' cognition and affect just before engaging in the task (described as "Internal Variables" in Fig. 1). The initial conditions are key to determining how the system components will interact with and affect one another either positively or negatively resulting in unpredictable outcomes and changes in the system behavior. Such changes can be gradual or sudden, and for this reason, they need to be observed over time. They can also be at an intra-individual level (e.g., motivation, cognition) or at the interpersonal level (e.g., student-student, teacher-student interactions). Emergent behavior will not be reversible to its initial condition. That is, a previous state determines the next emergent outcomes, and these outcomes will constitute the basis of the next state (Kaplan and Garner, 2017). Because the initial conditions of different systems will always differ, implementing the same strategies in two different contexts will result in different unpredictable outcomes. Although systems exhibit these ongoing changes and unpredictable characteristics, they can still exhibit certain stability and patterns. Hilpert and Marchand (2018) explain this paradox by noting that complex systems "require a large amount of information about past system behavior to produce a forecast about its future behavior patterns over a longer time horizon" (p. 190). Therefore, it is crucial to analyze system fluctuations and changes over time as a response to internal and external perturbations.

Although many educational phenomena manifest CDS characteristics, such complex behaviors have mostly been studied from the perspective of traditional, linear, cause-effect approaches. It is clear that those traditional approaches are inadequate in explaining educational phenomena, which are by definition complex, dynamic, and nonlinear. CDS theory is one of several systems approaches—including complexity theory (Kauffman and Kauffman, 1995; Poupore, 2018), complex adaptive systems (Holland, 2006), critical systems thinking (Jackson, 2001), and system dynamics (Groff, 2013)—that offer promising and inspiring alternative ways of thinking and tackling systemic phenomena within different disciplines (Schwaninger, 2009). We chose to use CDS as the theoretical framework in the present study because it has been used by educational researchers to align theory and methodology in educational psychology and because it lays out a theoretical perspective to better capture the nature of complexities over time within educational settings (Hilpert and Marchand, 2018). Other recent studies in education have also used a CDS approach to create a framework for incorporating and applying systems approaches (Kaplan & Garner, 2017, 2020). In addition, the CDS theory works well with the MUSIC model theory because the MUSIC variables serve as a descriptive reduction of the motivational climate in complex learning environments (Jones et al., *in press*). As explained by Geveke et al. (2017), "the behavior of the entire complex system is mapped onto this small set of descriptive variables, and important properties of the complex system may be understood by studying its behavior over time in this highly reduced descriptive model" (p. 2). Consequently, we used the CDS approach to examine the dynamics within and among students' MUSIC perceptions over time in an online course.

3. Research methodology

3.1. Participants and course

Participants were students in an online course at a large public

university in the eastern U.S. The participants were enrolled in a master’s-level course within the field of education. The students were either undergraduates who planned to become K-12 teachers or master’s students who were already enrolled in a master’s degree in education. Students completed five reflection surveys at five different times throughout the course as part of their course assignments. Of the 57 students enrolled in the course, six students were not included in this study because they did not complete all of the surveys. Therefore, the study sample consisted of the 51 students (89.5%) who completed all five of the surveys. We obtained the anonymous student survey responses from the instructor after the course was completed. In addition, we informally interviewed the course instructor about the usefulness of the results and his plans for using the results to improve the course in the future. The study procedures were reviewed by the Institutional Review Board at the authors’ university.

During the course, students watched videos prepared by the instructor, read textbook chapters, and completed multiple-choice quizzes and other assignments (see Table 1). Students completed 10 quizzes (that covered the content within the videos and chapter material) and a comprehensive multiple-choice exam (that included material from the entire course). The written assignments and case study required students to apply the concepts from the chapter material or to reflect on their learning. In addition, students completed five surveys to assess their perceptions of the course. Students’ final grades were based on their quiz scores (62.1% of their final grade), written assignment scores (17.2%), final exam score (10.3%), case study score (6.9%), and survey completion score (3.4%).

3.2. Procedures and study design

Students completed five online surveys during weeks 2, 4, 6, 10, and 12 to allow the material from two chapters to be covered between each survey administration (except for the first survey, which was completed in week 2 after the first chapter, see Table 1). We did not collect data at the initial state, which was at the beginning of the course, because students did not know much (if anything) about the course at that time. The surveys were administered through an online survey tool called Qualtrics® that allowed the instructor to create an online survey, administer the online survey through a URL link emailed to the students,

Table 1
Weekly listing of course quizzes, assignments, surveys, and survey constructs.

Week	Quiz/Assignment/Survey	Variables Measured on the Survey
1	Written assignment	
2	Chapter 1 Quiz	
2	Survey 1	Course motivation, MUSIC perceptions
3	Chapter 2 Quiz	
3	Written assignment	
4	Chapter 3 Quiz	
4	Survey 2	MUSIC perceptions
5	Chapter 4 Quiz	
6	Chapter 5 Quiz	
6	Survey 3	Course motivation, Course effort, MUSIC perceptions
7	Chapter 6 Quiz	
	Spring Break	
8	Prepare for Case Study assignment	
9	Case Study assignment	
10	Chapter 7 Quiz	
10	Survey 4	MUSIC perceptions
11	Chapter 8 Quiz	
12	Chapter 9 Quiz	
12	Survey 5	Course motivation, Course effort, MUSIC perceptions
13	Assignment	
13	Chapter 10 Quiz	
14	Written assignment	
15	Final Exam	

and retrieve the results of the survey by downloading it to an Excel spreadsheet. The instructor limited the number of surveys administered in the course to five in order to avoid survey response fatigue. Students completed the surveys as assignments and were given full credit for each survey assignment if they completed all of the survey questions. To avoid students feeling pressured to respond to the survey in a desirable manner, the instructor did not review the results of the surveys until the course was completed.

Students’ course motivation (i.e., their intent to engage in the course) was assessed at three times during the course (in Survey 1, 3, and 5) and their perceived course effort (i.e., the amount of effort they believed they put forth in the course) was assessed twice during the course (in Survey 3 and 5). The instructor did not assess students’ course effort at the beginning of the course on Survey 1 because at that point they had only completed one short assignment and one quiz, neither of which required much effort.

3.3. Measures

The surveys included items from three scales and some individual items, all of which are described in this section. All of the closed-ended items were rated on the same six-point Likert-format scale: 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Somewhat Disagree*, 4 = *Somewhat Agree*, 5 = *Agree*, and 6 = *Strongly Agree*. The items in each scale were averaged to create a mean scale score.

3.3.1. MUSIC® Model of Academic Motivation Inventory

The MUSIC® Model of Academic Motivation Inventory, college student version (MUSIC Inventory; Jones, 2012/2021) was included in all of the surveys and is comprised of five scales: a five-item eMpowerment scale, a five-item Usefulness scale, a four-item Success scale, a six-item Interest scale, and a six-item Caring scale. The scales measure the degree to which students perceive that: (a) they have control of their learning environment in the course (empowerment scale), (b) the coursework is useful to their future (usefulness scale), (c) they can succeed at the coursework (success scale), (d) the instructional methods and coursework are interesting (interest scale), and (e) the instructor cares about whether they succeed in the coursework and cares about their well-being (caring scale). Example items from each scale include: “I had the freedom to complete the coursework my own way” (empowerment), “I find the coursework to be relevant to my future” (usefulness), “I am confident that I can succeed in the coursework” (success), “I enjoy completing the coursework” (interest), and “The instructor cares about how well I do in this course” (caring). The scales in the inventory have been shown to produce reliable and valid scores when used with university students in online and face-to-face courses (Jones, 2010, 2019; Jones and Skaggs, 2016; Wilkins et al., 2021). We computed the Cronbach alpha values as measures of internal consistency reliability for our sample, which resulted in five alpha values (one for each MUSIC scale) for each of the five surveys, for a total of 25 alpha values. Four of the alpha values were good (between 0.83 and 0.89) and 21 of the values were excellent (between 0.90 and 0.96). The alpha values ranged from 0.83 to 0.96 for the empowerment scale, 0.92 to 0.96 for the usefulness scale, 0.84 to 0.93 for the success scale, 0.93 to 0.95 for the interest scale, and 0.86 to 0.93 for the caring scale.

3.3.2. Course effort

The Course Effort scale (Jones, 2019) measures the amount of effort that students believe they put forth in a course. It is comprised of four items that students responded to while thinking about the quizzes and assignments they completed since the last time they were asked about their motivation in the course in the prior survey. Specifically, students were told: “When responding to the following items, please consider all the different types of work you completed related to the last 5 assignments.” On Survey 3, they were reminded that these assignments included a written assignment and the quizzes for Chapters 2, 3, 4, and

5. On Survey 5, they were reminded that the assignments included the Case Study assignment and the quizzes for Chapter 6, 7, 8, and 9. The items for both of these surveys were the same: (1) "I did the best work I could have done for those assignments," (2) "I tried my hardest to do very well in those assignments," (3) "For those assignments, I put forth my maximum effort," and (4) "I did as much as I could do to learn the material for those assignments." In the present study, the internal consistency reliability of the scale was excellent ($\alpha = 0.94$ for Survey 3 and $\alpha = 0.93$ for Survey 5).

3.3.3. Course motivation

The Course Motivation scale measures students' intent to engage in the course. The scale items were modeled after the four items in the Course Effort scale. The items were similar except that all of the items were preceded by the phrase, "In this course, I intend to." We designed the scale in this manner because motivation is defined as the intent to engage in an activity or course. The items were as follows: (1) "In this course, I intend to do the best work I can do," (2) "In this course, I intend to try my hardest to do very well," (3) "In this course, I intend to put forth my maximum effort," and (4) "In this course, I intend to do as much as I can do to learn the material." The internal consistency reliability of the scale was excellent in the present study ($\alpha = 0.89$ for Survey 1, $\alpha = 0.92$ for Survey 3, and $\alpha = 0.93$ for Survey 5).

3.3.4. Open-ended course effort item

To understand why students put forth the level of effort they put forth, they were asked two open-ended questions on Surveys 3 and 5: (1) How much effort did you put into the last 5 assignments? and (2) Why put this amount of effort into the last 5 assignments? The first question was asked to trigger students' memory about how much effort they had put forth so that they could provide a more accurate answer to the second question.

4. Results and discussion

The purpose of this case study was to examine how an instructor can use data obtained from an online survey tool to assess changes in students' motivation, effort, and MUSIC perceptions over time in an online course. In this section, we present the results of the case study and explain how these results can be interpreted and used to improve the motivational climate within the online course.

4.1. Students' course motivation and course effort

Students' motivation to engage in the course was the highest at the beginning of the course (Survey 1, $M = 5.6$, $SD = 0.54$), but it also remained high during the middle (Survey 3, $M = 5.3$, $SD = 0.74$) and near the end of the course (Survey 5, $M = 5.2$, $SD = 0.82$) (see Fig. 2).

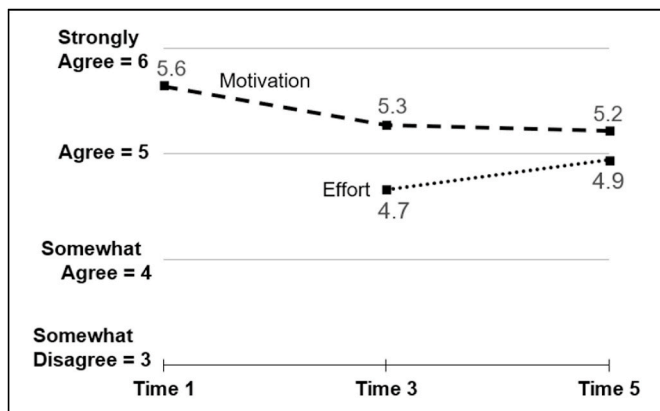


Fig. 2. Students' motivation and effort in the course.

Students' course effort was also fairly high during the middle of the course (Survey 3, $M = 4.7$, $SD = 1.01$) and near the end of the course (Survey 5, $M = 4.9$, $SD = 0.95$). These results suggest that students perceived the course to be motivating and they put forth a fairly high amount of effort to engage in the course. Viewed from the perspective of CDS theory, the instructor's intent to design a motivating course (an external variable in Fig. 1) interacted positively with students' internal variables which, in turn, resulted in stability in students' motivation and effort. This stability, by definition, is considered the attractor or equilibrium state in which the students (as components of the system) perceived that the course was motivating and worth putting forth effort into. The motivation and effort patterns identified in this course as a CDS provide the instructor with valuable information and offer a window into how students respond to certain aspects of the course, which then enable the instructor to make better predictions and decisions about the future system behavior.

To determine if students' level of engagement (i.e., their reported effort in the course) was the same as their level of reported motivation (i.e., their intent to engage in the course), we conducted paired-samples t-tests. We found that students' motivation at the beginning of the course (as reported on Survey 1, $M = 5.6$) was statistically significantly higher ($p < .001$) than the course effort that they reported putting forth during that time (as reported on Survey 3, $M = 4.7$). Similarly, students' motivation reported on Survey 3 ($M = 5.3$) was statistically significantly higher ($p < .001$) than the course effort that they reported putting forth during that time on Survey 5 ($M = 4.9$). These findings indicate that, on average, students overestimated the amount of effort that they would put forth in the course. In other words, although they had intentions to put forth a lot of effort in the course, their actual reported effort for that time period was somewhat lower than what they had predicted.

The MUSIC model presented in Fig. 1 can be used to explain this discrepancy between students' motivation and effort. Students' motivation for a course is affected by the other activities for which students are motivated (as indicated by the "cost/benefit decisions" rectangle in Fig. 1). In the open-ended survey item, students who did not put forth as much effort as they had intended often noted that they did not have enough time to put forth more effort, typically because they were busy with other activities (e.g., assignments in other courses, activities outside of school) or did not use effective time management strategies (i.e., they spent time on other activities instead of course activities). Some students reported that they put forth enough effort to get the grade that they desired, and we speculate that the time needed to get this grade was less than what some students expected. Students who reported putting forth a lot of effort typically did so because of their usefulness and/or interest perceptions. For example, they wanted a high grade (i.e., it is useful to their future to obtain a high grade), believed that the course content was useful for their future career as a teacher, and/or were interested in specific content. Students reported statistically significantly higher effort on Survey 5 ($M = 4.9$) than on Survey 3 ($M = 4.7$) ($p < .01$). Compared to Survey 3, the responses to the open-ended items in Survey 5 included fewer explanations as to why they did not put forth effort and more explanations that they put forth effort because they wanted a high grade, or they found the course useful or interesting. We speculate that as the end of the course drew closer, students began thinking more about their final grade and realized that they needed to put forth more effort to achieve the grade they desired.

4.2. Students' MUSIC perceptions

To assess how students' MUSIC perceptions changed over time in the course, we calculated the means for each MUSIC scale and presented them in Fig. 3. The average class scores for students' MUSIC perceptions were relatively stable over time. On the six-point scale, the differences within any one MUSIC component were less than or equal to 0.5, with differences of 0.5 for success, 0.4 for empowerment and interest, 0.3 for usefulness, and 0.2 for caring. Some MUSIC components were rated with

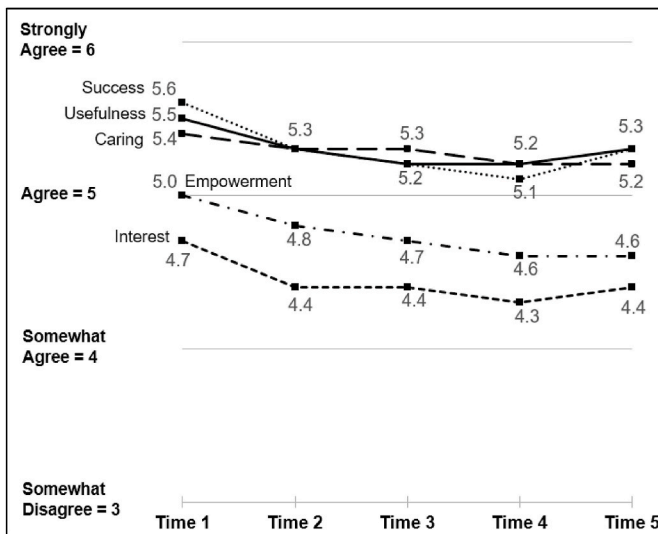


Fig. 3. Students' MUSIC perceptions at five time points during an on-line course.

the same score at more than one time point (e.g., empowerment was rated 4.6 at Time 4 and 5) which demonstrated that the students as a complex system remained in an attractor state over these time points where the perceptions of empowerment remained stable without any fluctuations or perturbations which would force the system to move and undergo changes. Some components changed over different time points (e.g., success was rated 5.6 at Time 1 and 5.3 at Time 2). The scores for all of the MUSIC components decreased from Time 1 to Time 2. That is, the students as the interdependent components of this complex system were forced to move away from their attractor state in Time 1 by a perturbation that resulted in a change manifested by a decline in their perceptions. This led to an overall stable attractor state in which the average scores on all MUSIC scales were relatively stable from Time 2 to Time 5. Because students were not asked specifically why their MUSIC perceptions decreased from Time 1 to Time 2, we can only speculate that the initial state at the beginning of the course or the Chapter 1 materials led to higher ratings at Time 1. For example, the Chapter 1 reading was shorter than the readings in the other chapters, which may have led students at Time 1 to believe that the course would not require much time and that it would be easy to be successful. However, at Time 2 their perceptions changed after reading the next two chapters, which were longer and included more complex concepts (resulting in success perceptions decreasing from 5.6 at Time 1 to 5.3 at Time 2).

Finally, empowerment and interest were consistently rated lower than success, usefulness, and caring. Studies that have included a variety of undergraduate courses and disciplines have also documented that students' perceptions of empowerment and interest tend to be lower than usefulness, success, and caring (Jones et al., in press; Jones, 2010).

The instructor reported that the results in Fig. 3 were useful because they indicated that students' perceptions of usefulness, success, and caring were quite high and that the course design appeared to be effective in these three areas. However, because empowerment and interest were rated lower, there was an opportunity for improvement in those two areas by incorporating motivational strategies that would serve as attractors and raise those scores. Therefore, the instructor reviewed the course materials and methods to consider how different teaching strategies could improve students' perceptions of empowerment and interest. Jones (2018) provides many possible example strategies, such as adding variety to increase interest and giving students more choices to increase empowerment perceptions. After reflecting on these results and considering the current structure of the course, the instructor realized that students' final course grade relied heavily on

quizzes (62.1% of their final grade) and these quizzes may not be overly interesting to students. Knowing that one way to increase students' interest is to add more variety, the instructor decided to change the course in the future by designing assessments other than multiple-choice quizzes for some of the chapters. In some chapters, he decided to administer shorter quizzes worth fewer points and also provide shorter assignments that asked students to engage in activities involving the application of concepts (e.g., write a letter to their fictitious students' parents about a concept covered in the textbook) or requiring students to demonstrate their knowledge in a different format (e.g., concept maps). These types of assessments may not only increase interest, but they may also give students choices (e.g., choices in what to include in the letter, choices in how to create a concept map), which could increase students' perceptions of empowerment.

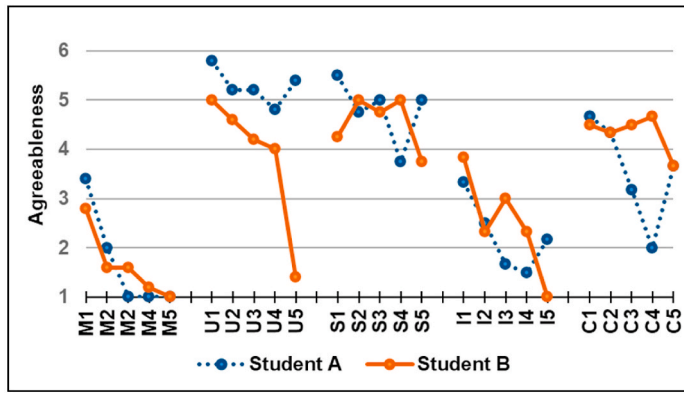
4.3. Perceptions at the individual student level

So far, we have investigated the assessment results at the class level by examining the average scores of students in the class. However, these data can also be examined at the student level by selecting the scores from individual students. To demonstrate, Fig. 4 shows how two students' MUSIC perceptions varied over the five time points. The two students reported similar MUSIC perceptions for some time points, yet very different perceptions at other time points. For example, their perceptions of usefulness (U) were similar and parallel to each other until Time 5; then, Student A's perception increased from 4.8 (U4) to 5.4 (U5) while Student B's perception decreased from 4.0 (U4) to 1.4 (U5). Also, both Student A and B perceived success (S) similarly at time points 2 and 3, yet their perceptions differed at Times 1, 4, and 5. Because the system demonstrated variability for Student A at Time 4 for success (S4), S4 can be considered a *repellor* state for this student. The system then returned to an attractor state in Time 5 (S5) that was similar to the state at Times 2 (S2) and 3 (S3).

Fig. 5 shows how two students' perceptions can be similar for some MUSIC components and very different for others. The two students' perceptions were similar and fairly high for empowerment (M) and success (S) at all five time points; however, their perceptions of usefulness (U), interest (I) and caring (C) were quite different. For example, Student C rated usefulness (U) 6.0 at all of the time points, and thus, it can be considered to be in a stable attractor state. In comparison, Student D's ratings for usefulness ranged from 1.6 to 3.4, which are much lower than Student C's ratings. Student D was in a *repellor* state at U1 and then maintained more of a stable attractor state for usefulness at Times 2 to 4.

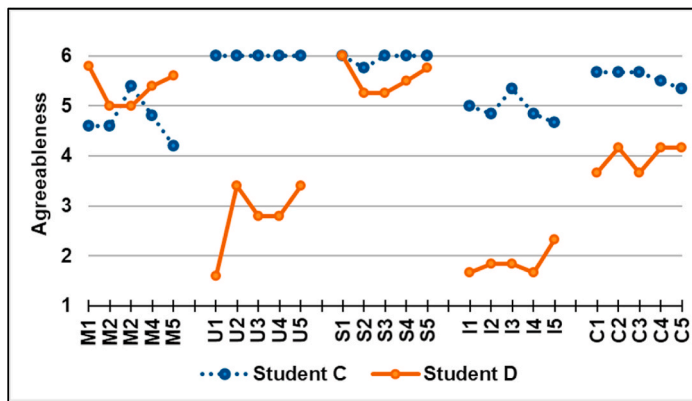
To gain further insight into the effort of Student C and D, we examined their course effort ratings and their responses to the open-ended items. Student C rated their course effort as 5.00 for Survey 3 and 4.50 for Survey 5. In the open-ended item, Student C wrote that "I believe that this information will help me as a new teacher" (referring to the information in the course chapters covered during those weeks), which could explain why they reported the highest value (6 = *Strongly Agree*) for usefulness (U) at all five time points. In contrast, Student D rated their course effort as 3.25 for Survey 3 and 2.00 for Survey 5. Student D explained in the open-ended item, "I put in enough effort to earn a good grade. My goal in this course is to get a good grade." For whatever reason (we cannot know based on the data collected in this study), Student D did not find the course to be useful (beyond the usefulness of the grade for their future) or interesting, which appears to have resulted in lower effort and a primary focus on their final course grade. Thus, their attractor state was lower than that of Student C for usefulness (U) and interest (I).

Fig. 6 shows six students from the course and the changes in their perceptions of empowerment as they responded to the demands of their learning environment. Students' perceptions of empowerment were similarly high at Time 1; therefore, this can be considered an attractor state because high variability in system behavior was not observed for



Note. “M1” refers to the eMpowerment scale score on Survey 1, “M2” refers to the eMpowerment scale score on Survey 2, and so forth. “U” refers to the Usefulness scale score, “S” refers to the Success scale score, “I” refers to the Interest scale score, and “C” refers to the Caring scale score.

Fig. 4. MUSIC perceptions for Student A and B at five time points.



Note. “M1” refers to the eMpowerment scale score on Survey 1, “M2” refers to the eMpowerment scale score on Survey 2, and so forth. “U” refers to the Usefulness scale score, “S” refers to the Success scale score, “I” refers to the Interest scale score, and “C” refers to the Caring scale score.

Fig. 5. MUSIC perceptions for Student C and D at five time points.

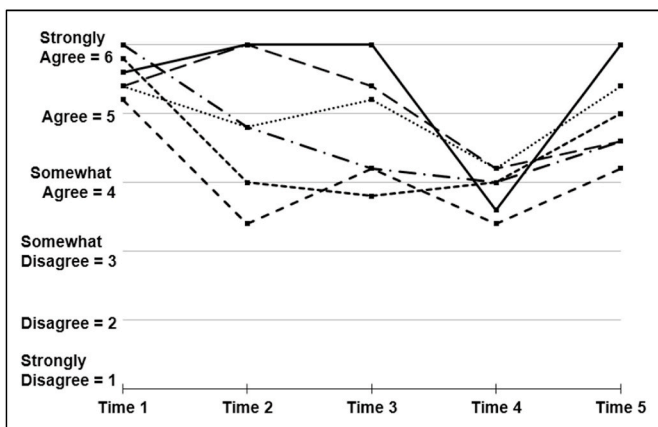


Fig. 6. Empowerment perceptions for six students at five time points.

these students. However, this stability was perturbed towards a change at Time 2 and Time 3 (with the exception of one student who remained at the same score from Time 2 to 3). Therefore, between Times 1 and 4, a few students entered a repeller state of disequilibrium manifested by fluctuations and high variability in system behavior. The system started to draw away from the repeller state and disequilibrium as a self-regulating response to settle back into a more stable attractor state at Time 4 where fluctuations significantly decreased. This stability was manifested by an overall decrease in their perceptions of empowerment. Such a decline was not what the instructor desired; however, complex dynamic systems will always self-regulate to move away from repellers that create disequilibrium whether such a shift is desirable or not. Time 4 can be considered an attractor state because the students maintained equilibrium by perceiving that they had only some control over their learning and they all settled in this perception. However, this stability was perturbed again at Time 5 where the system behavior was forced to move and undergo another change in their perceptions that led to a movement towards an increase in empowerment at Time 5 as a result of self-regulating system behavior.

It is unknown what factors caused such fluctuations in students'

perceptions of empowerment across time points in this study. We were limited in our analysis because the instructor did not examine the results throughout the course (in order to increase the chances that students would reply to the survey honestly). However, such an assessment and examination of results during a course could allow instructors to map the relations among internal and external variables, as well as intra- and interpersonal interactions across time points. This could also provide a reminder for instructors to periodically review their course design, instruction, and any activities that students engage in to be able to make adjustments as needed. CDS literature emphasizes that, despite the unpredictability of system behaviors, collecting as much information about past system behavior as possible enables instructors to make predictions about future system behaviors (Hilpert and Marchand, 2018).

One possible explanation for the decrease in empowerment from Time 1 to Time 2 for four of the students may be that they initially perceived that they had a lot of control and could make choices within the online course, such as not having to attend class at a specific time and the ability to choose when to study and complete the assignments. However, by Time 2, they may have felt less empowered because they had few choices about *what* to study and were *required* to complete certain activities within each week.

The MUSIC perceptions of one of the students included in Fig. 6 is also shown in Fig. 7. This figure shows that all of the MUSIC perceptions except interest began at the value of 6.0 at Time 1. Then, success remained at the stable attractor state of 6.0 through four time points until Time 5 when it dropped slightly to 5.5. This shows that the student did not go through any repeller perturbations caused by external variables that would force them out of the attractor stability they maintained for success until Time 5. Usefulness and caring also remained at or near 6.0 for three time points until they dropped significantly to 3.6 and 4.2, respectively, at Time 4. Then, they increased to 5.8 (usefulness) and 4.8 (caring) at Time 5. Empowerment and usefulness both decreased after Time 1 and remained in a fairly stable attractor state during Times 2 to 5.

Similar to Figs. 4 and 5, the findings in Fig. 7 indicate that variation can occur across MUSIC perceptions for one student. However, stable attractor states can also occur over two or more time points. This is expected in a CDS because the system components tend to remain in attractor states unless they are perturbed by external forces in the environment. In Fig. 7, the student's perception of usefulness shows that the changes can be gradual or sudden, which is one of the characteristics of complex dynamic systems. Although usefulness remained 6.0 for the first three time points, it significantly decreased to 3.6 at Time 4 and increased to 5.8 at Time 5. The changes in this case are sudden and significant; that is, the shifts in the perception of usefulness did not spread over a long period of time. This is expected as the strength of perturbation will determine not only whether the system will undergo a change (and the magnitude of the change) or resist it, but also whether the change will occur gradually or suddenly. Such an assessment of students' MUSIC perceptions over time offers some insight into the

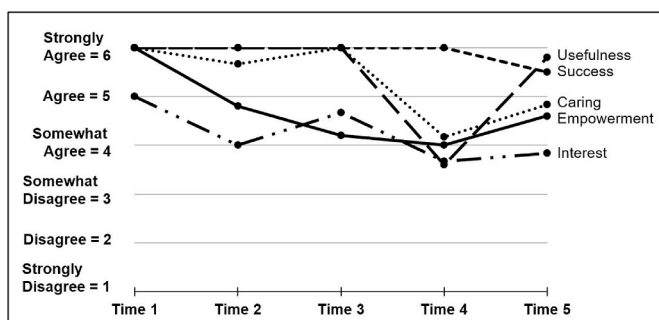


Fig. 7. The MUSIC perceptions of one student over five times during the course.

impact of specific activities and the magnitude of their impact. This assessment can also help the instructor narrow down the possibilities of external factors that could cause such perturbations at specific time points. For example, the low ratings for four of the MUSIC perceptions at Time 4 may be due to the fact that between Time 3 and Time 4, students completed the Chapter 6 quiz, went on spring break, completed a case study over two weeks (that involved reading a short book and completing a written assignment), and completed the Chapter 7 quiz the following week (that involved watching videos and reading the textbook). The teacher has used the case study for many years and reported that students find it interesting and useful. Therefore, when students completed the survey at Time 4, even though they were supposed to consider all of these course activities, they may have been comparing the Chapter 7 quiz they completed immediately prior to the survey to the case study. In comparison to the case study, the Chapter 7 quiz may have been perceived as less useful and interesting, as providing less empowerment, and as making the instructor appear less caring. Future studies could include questions that asked students why they rated their perceptions in a certain way.

5. Conclusion, implications, and further research

5.1. Conclusions

This case study examined a process through which instructors can use data obtained from an online survey tool to assess the motivational climate in an online asynchronous course. By investigating this process, we conclude that digital assessments can (1) lead instructors to become more effective course managers, (2) lead to more effective individualized instruction, and (3) provide a means to train instructors to become better teachers. We explain each of these conclusions in this section.

First, digital assessments that provide feedback about the motivational climate can help instructors become more effective at managing their courses. Administering the survey at five times during the course allowed the instructor to examine how students' motivation, effort, and MUSIC perceptions changed over time as a response to changing conditions and perturbations in the learning environment. The instructor used this information to make data-driven instructional decisions to design and improve instruction the next time he taught the course; and thus, he became a more effective online course manager. As a course manager, instructors must plan instruction ahead of time because, from a CDS perspective, the learning environment as a complex system is sensitive to initial conditions. Instructors must also be flexible and willing to make changes during the course to foster students' motivation and learning, as complex interactions between the instructor, students, content, and instructional activities will result in emergent outcomes and changes in student behavior over time due to the dynamic nature of such complex systems. By attending to the feedback, the instructor can support the course as a CDS to self-regulate itself to return to a more stable attractor state when it experiences perturbations.

Second, digital assessments of the motivational climate can allow instructors to better meet the needs of individual students. Sometimes, students' course perceptions were similar; for example, when Student A and Student B in our case study rated empowerment similarly (see Fig. 4). Yet, some students, such as Student D in our case study, may rate the usefulness of the course much lower than other students. In this case, the instructor can use these results to consider why this student rated usefulness lower and if there is anything he can do to help this student understand why the course is useful. For instance, the instructor could email or talk to the student about why the student believes the course is not useful. Although it is not possible to force a student to change their perception of usefulness, understanding students' perceptions gives instructors insights into diverse perspectives that can help them to consider alternative instructional strategies that could foster changes in students' perceptions. As other examples, the instructor could create an assignment for which students relate the content to their everyday life,

allow students to reflect on the usefulness of the content and share their ideas with other students in the online discussion board, or use videos or online guest presenters to explain how the content is useful (Jones, 2018).

Third, we believe that digital assessments of motivational climates can be used as a means to train instructors to become better teachers. It is reasonable to suspect that most instructors know something about teaching strategies that can be used to motivate students. Yet, it is also reasonable to suspect that many instructors either do not prioritize motivational teaching strategies—and instead focus mostly on learning strategies—or are unfamiliar with current motivation research and how it can be used to inform their teaching practices. Asking instructors to assess students' MUSIC perceptions not only provides them with motivation-related data, but it also focuses their attention on five motivational perceptions that are related to students' motivation and engagement. Assessing students' MUSIC perceptions and giving instructors the results can focus the instructors' attention on these five perceptions. Instructional trainers or professional developers can then use the MUSIC model to discuss the role of motivation in learning and help instructors connect strategies associated with each of the five MUSIC perceptions. The MUSIC model website (www.theMUSICmodel.com) may be a useful tool for instructional trainers, professional developers, and instructors to consult for motivational strategies.

5.2. Implications and further research

The most obvious practical implication is that instructors should use the MUSIC Inventory to assess the motivational climate of online courses because it can help them make data-driven decisions about motivational strategies. The inventory can be administered at various times throughout the course and can be used to document changes in students' MUSIC perceptions of five key motivational components over time. The course effort scale and the associated open-ended effort item were also useful in providing the instructor with insight into how much effort students were putting into the course and why they were putting forth that much effort. The responses to the open-ended item were especially useful in helping to place the quantitative findings in perspective because students explained things in their own words. It may also be useful for teachers to talk to students formally or informally about motivation-related issues to better understand their perspectives (e.g., asking them what they found interesting about the most recent topic).

Because this study was conducted in an online asynchronous course, students did not interact with one another. Future studies could be conducted in face-to-face courses or online courses that require student interactions to examine the effects of these student-to-student interactions on students' MUSIC perceptions.

By conducting this case study, we found that it takes some time to collect the data and analyze it. Setting up the online survey tool was not difficult, but it took some time. Once the survey is created online, however, it can be copied and reused easily. Also, the online website we used for the surveys calculated the total MUSIC scale scores (i.e., it summed the values of each of the items in the scale), but it could not calculate the mean MUSIC scale scores (i.e., divide the total scale score by the number of items); therefore, we downloaded the results to a spreadsheet and computed the scale averages. This process could be confusing and time consuming for instructors unfamiliar with this process. Identifying software or an online website (e.g., www.theMUSICmodel.com) that could automate this process for teachers would be beneficial.

The instructor in this case study found the results useful as presented in Fig. 3. However, it may be possible to present the results in ways that are more useful to instructors. Future research could investigate other types of feedback, especially digital feedback that could be provided automatically by a website or software application. Such research could investigate questions such as: What feedback is most useful to instructors? and What tools are most effective in providing this feedback?

For example, are electronic spreadsheets, bar graphs, pie charts, or other visual displays useful to instructors?

Another practical consideration is how to collect students' MUSIC perceptions in a manner that is least intrusive to the instructional process. In the present case study, students completed the surveys online so that they were accessible through any device that had internet access (e.g., computer, tablet, phone). However, there may be more efficient means to collect data that are preferred by students.

It is unclear how many times students' motivation-related perceptions should be assessed during a course. The instructor chose to assess students' perceptions five times for practical reasons: completing it five times would likely not be too onerous to students, yet it would provide the instructor with data every couple of weeks or so. Because the average values on the scales did not vary much from survey to survey, it may have been possible to survey students fewer times; perhaps by not including Surveys 2 and 4. However, in other courses, students' motivation, effort, and MUSIC perceptions may change more often and more survey assessments may provide useful results. Future research could determine how many times students should be surveyed and at what point students experience survey fatigue.

A related implication was the need to understand whether some MUSIC perceptions are more stable over time than others. For example, it seems reasonable to suspect that students' perceptions of caring may be more likely to remain stable over time. In contrast, students' interest in the course activities could vary significantly from one activity to another. Future research could investigate if all five MUSIC perceptions need to be assessed the same number of times throughout the course or if some MUSIC perceptions can be assessed fewer times.

Declaration of competing interest

The authors declare that they have no student competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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