Engaging the Learner: How Can the Flow Experience Support E-learning?

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Abstract: This paper describes research into making e-learning activities motivating and engaging, yet still producing effective learning. Flow is used as an underlying theory to explore student behaviour during online instruction. In this study, 59 students worked through a learning exercise in physics while two different methods were employed to measure flow experiences. Graphical visualisations ('flow path' plots) were employed to show the dynamic nature of the students' experiences. These were found to be inconsistent with other traditional flow measurement techniques. The study identified the students' changing focus between task and artefact as a contributor to this inconsistency. A significant contribution of this paper is the identification of 'task-flow' and 'artefact-flow' and their significance in e-learning.

Introduction

There is a particular challenge for the designers of structured, online e-learning activities. If the learning material presented to students does not excite their interest, then the alluring world of games, entertainment and music is but a click away. If Web-based material is too confusing, too hard or challenging, the browser's quit button is also only one click away. The challenge for the e-learning designer is to engage learners in a way that will maintain their interest and keep their minds on the task at hand. For many of the learning activities designed during the past decade, the carrot to the student has been the bells and whistles offered by the ever-evolving Web-based multimedia technologies.

In this paper we argue that such a focus on the 'glitz' of the Web is not only inadequate but can also be distracting to learning. We draw on research investigating the use of flow theory as a theoretical base from which to examine students' engagement with online activities. Our findings highlight the importance of obtaining an appropriate balance in the design of e-learning materials so that the learner is attracted to the learning tasks, but not *dis*tracted by the software artefacts used to present them. The engagement we must achieve is partly one with the software, but also a more important one with the concepts to be learnt.

Background to Flow theory

What is Flow and Why is it Relevant to Learning?

In 1975 Csikszentmihalyi coined the term 'flow' to represent 'optimal experience' events in which a person enters a mental state of complete absorption or engagement with an activity (Csikszentmihalyi 1975). The flow experience is an all-encompassing one, leaving no room for other thoughts or distractions. Many of the elements of flow are ones that we readily associate with environments that promote learning: a sense of control, clear goals, timely and appropriate feedback, enjoyment, concentration, and a sense that the challenges being presented are just within reach of one's own skills to accomplish them. Researchers have noted the importance of flow in educational settings (Clarke & Haworth 1994; Shernoff, Csikszentmihalyi, Schneider, & Shernoff 2003) and are supported by research showing that flow occurs more often during study and schoolwork than other daily activities (Massimini & Carli 1988). In spite of this, there is no well-formed model of flow that can be applied directly to learning nor is there a well-established measurement technique in this learning domain.

A question to consider is whether we can expect a flow experience necessarily to enhance learning. Flow studies have described the joy and personal satisfaction of engaging in a flow experience (Csikszentmihalyi 1997), and have also explored flow looking for the more pragmatic aims of understanding the customer experience when using marketing websites (Novak, Hoffman, & Yung 2000). An e-learning experience is, however, different. The desired outcome is generally to acquire new knowledge or skills as pre-determined by the designer. A part of this experience may be to enjoy the motivating nature of the presentation, but the ultimate aim is for a deeper engagement with the concepts to be learnt. We want the learners to learn the course material presented, have an enjoyable time, yet feel enough in control to explore and take initiatives with their learning. This is in stark contrast to, for example, an e-commerce Web site that aims to engage the user for long enough to decide to make a purchase.

Measuring Flow During Learning

Several methods are commonly used to measure flow. The Experience Sampling Method (ESM), originally conceived by Csikszentmihalyi (Mihalyi Csikszentmihalyi, Larson, & Prescott 1977), involves the use of a pager to remind a subject to write answers to several probe questions at random times during the day over an extended period. A second approach to measuring flow has been to survey participants retrospectively about past activities that might include flow experiences. This has been done using data from large scale online surveys of general Web usage (Novak et al. 2000) as well as smaller surveys targeting a particular workforce (e.g. Ghani & Deshpande 1994). Flow has also been measured using retrospective surveys conducted immediately after an activity, often in a laboratory setting (Ghani 1995; Webster, Trevino, & Ryan 1993).

Measuring flow in a learning context presents particular challenges. A learning session is likely to involve many conceptual challenges hence the measurement instrument must be sufficiently fine-grained to track changes that might take place over a relatively short period of time (e.g. 30 to 60 minutes). A frequent comment in flow studies is that intrusive measurements may adversely affect the flow they are trying to detect, or that retrospective measures rely too much the vagaries of memory for events that have taken place only in the consciousness (Csikszentmihalyi & Csikszentmihalyi 1988). This is of particular concern in learning since the user is likely to be deeply engaged in conceptual thought. For these reasons, it is important that flow be measured either during or immediately after an interaction (Webster et al. 1993).

A measurement approach that addresses these issues is derived from the early representations of flow that recognised the importance of perceived challenges and skills during an activity (Csikszentmihalyi 1975). These are presented on a two-dimensional plot in Fig. 1. This 2-d space is divided into three regions labelled ‘anxiety’, ‘boredom’ and ‘flow’. Flow is represented by experiences where the perceived challenges are equal to the perceived skills. Other researchers have further divided this space into four, eight and even sixteen regions.

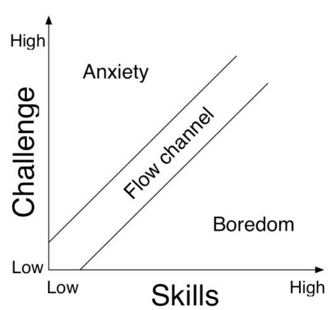

Figure 1: Csikszentmihalyi’s 3-channel flow model

This model illustrates that, for a learner to stay ‘in flow’, flow must be regarded as a dynamic process. A learner might begin at the lower left end of the ‘flow channel’ (Fig. 1) with skills that can *almost* cope with a challenge and strive to improve those skills to meet that challenge; this is the start of the learning process. Ideally, the challenge should then be increased to prevent the learner’s improved skills making the challenge appear too easy, as is represented by the region labelled ‘boredom’. As this process continues, the learner’s path will progress up the flow channel as new challenges stimulate the development of new skills (Csikszentmihalyi 1975).

The concept of skills being improved to meet ever increasing challenges is one that makes this particular ‘three channel’ model of flow an attractive one to employ in learning situations. It allows for a novice’s very elementary skills to be matched with an appropriately elementary challenge, and then to develop as the person learns and takes on greater and greater challenges. It also provides a method for measuring flow that is independent from the positive states of consciousness of the leaner (such as enjoyment, concentration, control, lack of self-consciousness, lack of distraction). The method involves recording the learner's perceived challenges and skills, and mapping them onto the 2-dimensional challenges-skill space. A key aspect of this is that it is based on the participant's judgements, not those of the designers of the activity. The perception of these challenges and skills has been described as 'theoretically, the most meaningful reference point for the presence or absence of flow' (Massimini & Carli 1988). This method has an advantage over other methods for use in a learning context in that it has minimal impact on the participant and is hence least likely to interfere with flow experiences.

Three methods for measuring flow are reported in this paper. Challenge and skill measures were made during an online learning task to monitor the dynamic nature of the flow process throughout the task. These data were compared to an 'overall-state' view of flow determined from survey questions administered at the end of the activity. Flow experiences are also described from post-interviews with participants. The interview structure was based on the nine elements of flow: goals, feedback, balance of skills and challenges, control, engagement, self-consciousness, merging of action and awareness, time distortion and enjoyment (Csikszentmihalyi 1975).

The Study

The aim of the study was to answer the questions "can we measure flow during learning?" and "is flow beneficial to learning?". Previous studies have identified that students often experience flow whilst in learning situations, but few, if any, have examined closely the flow experiences during a learning session.

The study comprised two parts. In the first part, 59 students in an Australian university participated in an experiment in which they worked through a highly interactive, online sequence of learning tasks in the area of physics. Quantitative analysis methods were used to gain insights into the patterns of flow experiences and how they related to learning. Details of this research is reported elsewhere (Pearce, Ainley, & Howard 2005).

The second part was a smaller qualitative study in which eight students undertook a slightly modified online learning experience. This was followed by individual interviews that aimed to identify any instances of flow, and to develop an understanding of how flow theory could be used to describe and understand their learning experiences.

Results and Discussion

Part One of the Study: Interpreting 'Flow Paths'

The first part of the study monitored students' flow experience as they worked through a sequence of seven online learning activities in physics. After each activity, presented as a single interactive Web screen, their perceived challenges and skills were recorded using two Likert-scaled questions: "How challenging did you find this last activity" and "Were your skills appropriate for understanding this last activity?'. In addition, questionnaires were administered online to gather information about the students' background, physics knowledge before and after, as well as post-questions seeking responses to affective items to give an overall indication of flow experiences during the complete session. This overall flow value was calculated from eleven questions relating to engagement, enjoyment and perceived control (Trevino & Webster 1992).

This process, showing the pre and post testing as well as the seven challenge-skill 'probes', is shown in Fig. 2.

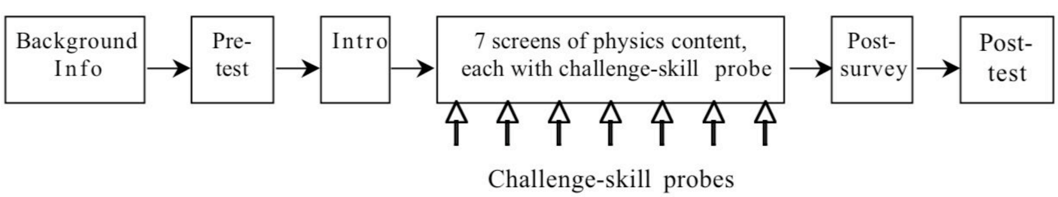

Figure 2: Progress through the activities

We examined the data recorded for a relation between flow, as indicated by balanced challenge-skills, and learning outcomes, as measured by the post-test. A visualisation of possible flow experiences was constructed by plotting the 'flow paths' for each student, based on their challenge-skill recordings. Plots for two students are shown in Fig. 3 and Fig. 4, respectively. Each grid square represents one of the 25 possible states defined by the two fivepoint Likert-scale measures of challenge and skill. The line shows their 'path' as they progressed through the seven activities of the learning exercise. The dotted diagonal line represents the ideal flow condition of 'challenge = skill'. The hollow circle represents the average, or 'centre-of-gravity', of that student's plot.

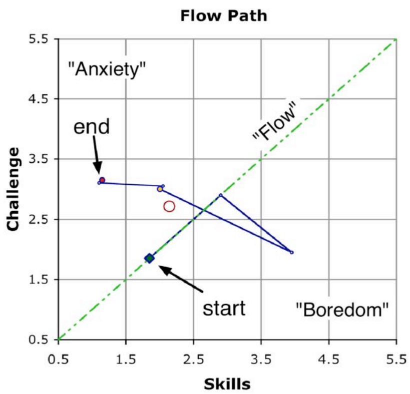

Figure 3: Flow path for a 'learner'

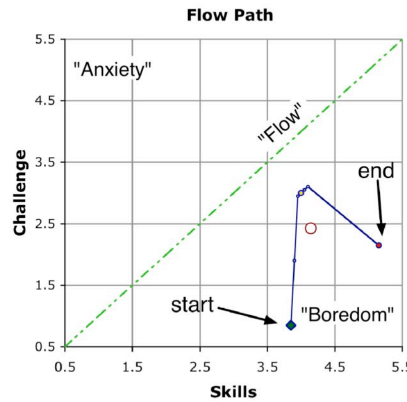

Figure 4: Flow path for a 'bored' student

Fig. 3, shows the flow path of a student who performed very well on the exercise in terms of learning outcomes. It shows that this student began the exercise with relatively low skills and perceived the first activity to be of relatively low challenge. By the second activity she was more challenged but also rated her skills as having increased to meet the challenge. The third activity presented less of a challenge and she still perceived her skills as increasing. The final two activities presented more challenge and this student reported her skills becoming increasingly less adequate for what the task required. Some of this plot is consistent with a flow model of learning: the student's perceived challenges and skills grew together through the first part of the learning exercise. However, for this student the final activities were difficult and she ended up in a state of some anxiety.

Fig. 4, shows the flow path for a student who scored a near perfect score on the pre-test but showed a degree of boredom ('relaxation' is a better term, as no student indicated directly that they were actually bored) during the process. This student obtained a lower score for his post-test than his pre-test! The plot shows the student beginning and ending well into the boredom region, with an excursion closer to the flow line for four of the screens. Further details of the methodology and analysis of these data are presented elsewhere (Pearce et al. 2005).

Although some individuals produced flow paths that confirmed the expected progress 'up the flow line' in association with learning, and others showed very anxious or relaxed patterns, there was no strong relationship between the patterns and learning outcomes. This was not an unexpected outcome since many factors impinged on the students' learning. However, what was unexpected was the lack of correlation between the flow path patterns and the post-survey questions at the end that measured an 'overall-state' measure of flow for the whole exercise. This latter measure did not predict or help explain the flow paths of the students. Some students showed a high level of flow, as measured by the affective measures from the post-survey, but showed little evidence of flow as shown by the flow paths. Conversely, others indicated a very low overall flow measure, yet had several instances of well-balanced challenge-skills, suggesting flow experiences.

The conclusion drawn from this part of the study was that flow is a complex process that exhibits a degree of turbulence during a learning session. This is in contrast to many previous studies that conceptualise flow as a more enduring "state" that people experience. An overall flow measure is of little value to describe such a dynamic process. A correlation of overall flow values with individual plots on the flow path suggests that the overall value was often biased by the student's memory of the final activity ('recency effect'). Flow paths have been a valuable contribution to the visualisation of this dynamic flow process giving insights into students' struggles through the activities.

Part Two of the Study: Student Views on Flow

The second part of the study sought a richer understanding of the students' flow experiences. Eight students worked through a revised physics exercise. Their interactions were video-recorded, and at the conclusion they were interviewed about their experience. We aimed to understand what aspects of the students' experience contributed to or indicated flow, and why the previous challenge-skill measures appeared not to be a good indicator of it.

A strong theme to emerge from the interviews was that the students had a tendency to focus at times on the concepts that they were learning (the 'task') and at other times on the software being presented to them to help them learn the tasks (the 'artefact'). The physics ideas presented (tasks) were often demanding, requiring the students to grapple with the vector nature of the velocity and acceleration of a cart being accelerated along a track. This required considerable concentration from students if they were to sort out the intricacies of these motions. However, the software (artefact) also vied for their attention. It was an interactive Shockwave simulation that allowed the students to push a representation of the cart long a track and observe the resulting motion both as an animated representation and as graphical plots of position, velocity and acceleration against time.

The comments that students offered during the interviews indicated how their attention moved between the task and artefact. Students were asked to use the simulation to explore and answer four specific questions. One student commented, "then you're trying to figure out two questions like, what they wanted me to see here, and then how does that relate to the actual question". Her focus was moving between the artefact and the task.

When students were questioned about specific elements of flow, their responses referred to task or artefact often depending on how well they were coping with their conceptual understanding of the task. Comments from two of the students illustrate this point. One student (S1) was bright and made significant learning gains during the session. She described two instances when she thought she experienced flow. She reflected on these times as being "probably when my thinking changed". Most of her engagement was with the learning task, rather than the simulation, and she explained how she preferred to learn "with words rather than pictures". However, she also indicated a degree of boredom with the simulation. Although the simulation was *not* challenging for her, she remained engaged with the learning task that clearly *was* challenging and it was this that dominated her challenge-skill responses and kept her interest. In response to being asked whether the challenge-skill probes reflected her boredom, she replied:

S1: "Not really because I learnt different things along the way. Like, I realised different things as I saw it from a different perspective. And then I kind of lost my concentration as I went down and I think that's how I reflected the boredom rather than not finding it challenging because the simulation wasn't challenging but the concept that I got from the simulation was challenging."

In that last comment she clearly distinguishes between the simulation (artefact) being of low challenge, and causing her boredom, even though the task was of high challenge. For challenge-skill comments, or Likert-scale measurements, to give reliable indications of flow, we clearly need to distinguish when the references are to the task and when they are to the artefact.

In contrast, the other student (S2) made no learning gains from his time working through the exercise. Yet he also described a flow experience; this he described in terms of being carried away within the environment:

S2: "It's like I wasn't here, somewhere alone with this machine doing something. Like separate from everything else because…we're just there for like time and then now you're out of it. It's like you entered a little place that's not normal for you."

This experience stayed with him for the duration of the learning session: "The whole time basically. When I started answering the questions I was not really here. I was like inside a place the computer had made for me to go."

The students' focus on either the task or the artefact helps to explain why the earlier flow paths did not appear to give a consistent picture of their flow experiences. No attempt had been made to direct students' attention to address one or the other. Their focus might have been on the task for some of the seven activities, and the artefact for others. Even less helpful would have been if their response to one of the questions (challenge, say) related to the task, but the other (skills) related to the artefact. For the ratio of challenge to skills to indicate flow we need to be sure that they reflect perceptions about the same cognitive activity. This suggests that existing techniques for measuring flow are inadequate in that they fail to disambiguate task and artefact. This study has identified a need for further research to develop measurement tools that address this issue.

Discussion and Implications

Task-flow Versus Artefact-flow

The challenge-skill measures, as well as the student interviews, highlight two important points regarding flow. First, any question intended to determine a measure of challenge or skill must establish what the student is focussing on while interpreting the question. A students' attention might focus on the learning task (the physics in this case) or the artefact used to explore the task (a simulation in this case). This distinction between task and artefact is not discussed in the flow literature, but is recognised by Finneran and Zhang (Finneran & Zhang 2003) as an important aspect of re-conceptualising flow theory for use in computer-mediated environments. If the task is challenging for the student's abilities, but not too challenging, then we can expect that the student will engage with the learning material and endeavour to construct meaning from it. If the goals are well set out, timely and appropriate feedback is provided, and the student perceives a sense of control and enjoyment from their work, then this experience can not only be aptly described as 'flow', but it is also likely to result in meaningful learning. We will refer this flow as 'task-flow' to distinguish it from the flow described in the following paragraph. It describes a highly desirable engagement with a learning task that achieves the designer's aim of changing the knowledge state of the student.

A second point to come from these interviews is that flow can occur in a manner that is not beneficial to learning – it may even distract from it. This occurred with the student S2 who showed many signs of experiencing flow, but his flow was with the artefact rather than the learning task. We refer to this as 'artefact-flow'. In this situation the attraction of the artefact was sufficient to engage the student without him ever giving adequate attention to the learning task. Artefact-flow is likely when a learning task presents a challenge that is perceived to be too great for students' skills. Such students might be fully engaged with the task whilst working through the set exercises, as is typical in flow. However, they may have no room left for other thoughts, hence may also exclude thoughts relating to the concepts that the instructional designer is hoping that they will learn. Given the difficulty of the learning task, these students will be happy to remain engaged with the artefact, follow the learning instructions, and yet have little awareness that their minds are not engaging in the intended manner.

Linking Flow with Learning

The most reliable indication of flow during this study has been analysis of interview data. Students could articulate well their responses to questions relating to the elements of flow. They appeared to readily recognise and identify with the concept of flow when it was presented to them. However this was not a convenient or practical method for measuring flow in learning situations, especially in an e-learning context where there may be no teacher present for follow-up interviews. The challenge-skill measurement technique was easy to implement yet gave inconsistent results.

We believe that challenge-skill questions that are targeted more specifically to the learning task and the artefact, respectively, may give a much better indication of flow. Whilst this study did not verify this conjecture, there was evidence pointing to it in the first part of the study. When the challenge-skill recordings for a group of 10 students who achieved the most significant learning gains were averaged and compared to those for a group who achieved the poorest learning gains (and actually scored less on their post-tests than their pre-tests), interesting patterns were observed. Fig. 5 shows the average challenge and skill scores, plotted separately, for the group of 'learners', and Fig. 6 the corresponding plots for the 'unlearners'. The vertical scales represent the groups' average scores on a 5-point Likert scale; the horizontal scale represents the seven screens that the students worked through (labelled p2 to p8).

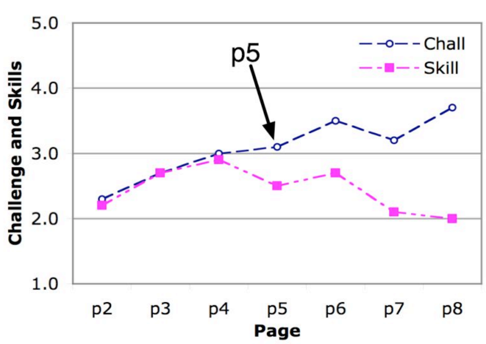

Figure 5: Average challenge and skills for 'Learners'

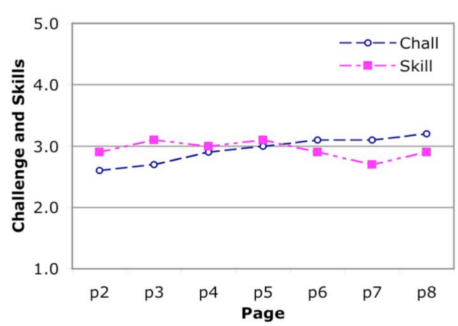

Figure 6: Average challenge and skills for 'Unlearners'

Figure 5 shows that the 'learners' were progressing well for the first three screens of the exercise with their challenges and skills in good balance and both improving as they learnt. The fourth screen (labelled 'p5') saw their perception of their skills decrease. This decrease was not due to a change in the demand in their artefact skills: they were required to carry out very similar interactions with the simulation that they had been doing all along. Clearly the drop in *perceived* skills relates to a focus on the learning *task* that had suddenly become beyond their abilities. The cause of this has been identified as a screen that presented the confusing concept of the simulated cart's acceleration being in the *opposite* direction to that of the motion. The tasks continued to become more challenging, and their skills to cope with them continued to decrease.

In contrast, the group of 'unlearners' (Fig. 6) maintained a reasonably steady perception of skills that was roughly balanced with their perception of challenges. If we focus on the learning task, it is hard to explain why these weak students did *not* perceive the provided challenges to be greater than their skills, especially considering that they had such trouble learning new ideas, or even holding onto what they already knew. They even appeared oblivious to the conceptual jump required to understand the fourth screen (p5). We interpret this as the students not engaging deeply with the learning task at all. If we conclude they were so out of their depth with the task that they focused on enjoying the artefact, then the challenge-skill plots make sense. Throughout the exercise they interacted with the simulation and did so for each activity presented. No screen presented any more of a challenge to their skills than any other screen because they did not develop sufficient cognitive engagement with the learning task itself. The attraction of the artefact, combined with the challenge of the task, has blocked their ability to interact with the task.

The interpretation of these plots for 'learners' and 'unlearners' suggests that we were really observing one group whose main focus was on the task ('learners') and another group whose main focus was on the artefact ('unlearners'). The indications of flow provided by these plots are commensurate with the learning gains of the groups. It is noted that the 'learners' indicated increasing challenge-skills measures resulting in movement up the flow channel of Fig. 1, whilst the 'unlearners' maintained balanced challenge-skills measures, consistent with an artefact that offered no increased challenges during the exercise.

Is Flow Beneficial to Learning?

From this research we conclude that flow can be beneficial to learning for two reasons. First, task-flow describes experiences in which the conditions for meaningful learning are established – clear goals, appropriate feedback, perceived challenges balanced by skills. These are conditions in which the learners have control over their environment and are fully engaged with the tasks at hand. They result in an uninhibited and highly enjoyable interaction with the learning materials. Such an experience, if ensuing from interactions with a learning task rather than a software artefact, can be expected to change a learner's knowledge state, that is, 'learn'.

Secondly, a flow experience is 'autotelic', that is, enjoyable for its own sake. Someone who experiences flow during an activity is likely to want to come back and experience it again. If we can achieve flow with students undertaking e-learning then we have a good chance of capturing their interest to return, or continue, rather than them being distracted by other activities.

Design Implications

In designing e-learning materials we are often tempted to incorporate interactive multimedia objects for affect; to catch the attention of students, entertain or motivate them such that the learning tasks take on a more attractive appeal. This research has highlighted a danger here. It is not just a concern that these multimedia objects might be gratuitous and offer no added value to the learner, but also that even well-designed objects offering sound pedagogical values, might hinder the students' learning. The designer's task is to use such elements cautiously. To build on their motivational and instructional value, yet maintain task challenges tailored for the individual students lest they become attracted to the lure of artefact-flow. The multimedia object inserts a layer between the students and their learning; it is the designer's job to make this layer transparent so that the students' focus of attention can move through to the learning task itself.

Conclusion

The research reported here presents a view that flow is an experience beneficial to students in a learning environment. The techniques to measure flow need to be further refined for the e-learning context. An understanding of how students experience flow in this context can offer valuable insights to those involved in e-learning design.

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