Measuring flow experience in an immersive virtual environment for collaborative learning

Paul van Schaik
Stewart Martin
Charles Wiz
Michael Vallance

a Teesside University
b Yokohama National University
c Future University Hakodate
Overview

• Background
• Method
• Results
• Discussion
• Conclusions
Flow experience

- ‘Holistic sensation that people feel when they act with total involvement’ (Csikszentmihalyi, 1990, p. 477)
- Not a matter of ‘all or nothing’ - can experience a degree of flow on each dimension
- Flow experience predicts learning-task performance over and above existing skills and knowledge (Engeser & Rheinberg, 2008)
- Flow is an independent positive predictor of task outcome in
  - computer-game playing (Murphy et al., 2008)
  - mathematics performance (Heine, 1997; Engeser & Rheinberg, 2008),
  - foreign-language performance (Engeser & Rheinberg, 2008)
  - computer-based statistics performance (Vollmeyer & Imhof, 2007)
## Dimensions of flow experience (Jackson & March, 1996)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balance of challenge and skill</td>
<td>“The person perceives a balance between the challenges of a situation and one’s skills, with both operating at a personally high level.” (p. 18)</td>
</tr>
<tr>
<td>Mergence of action and awareness</td>
<td>“The flow activity is so deep that it becomes spontaneous or automatic.” (p. 18)</td>
</tr>
<tr>
<td>Goal clarity</td>
<td>“Goals in the activity are clearly defined (...), giving the person in flow a strong sense of what he or she is going to do.” (p. 19)</td>
</tr>
<tr>
<td>Feedback</td>
<td>“Immediate and clear feedback is received, usually from the activity itself, allowing the person to know he or she is succeeding in the set goal.” (p. 19)</td>
</tr>
<tr>
<td>Concentration</td>
<td>“Total concentration on the task at hand occurs when in flow” (p. 19)</td>
</tr>
<tr>
<td>Control</td>
<td>“A sense of exercising control is experienced, without the person actively trying to exert control.” (p. 19)</td>
</tr>
<tr>
<td>Loss of self-consciousness</td>
<td>“Concern for the self disappears during flow as the person becomes one with the activity.” (p. 19)</td>
</tr>
<tr>
<td>Transformation of time</td>
<td>“Time alters perceptibly, either slowing down or speeding up” (p. 19)</td>
</tr>
<tr>
<td>Autotelic experience</td>
<td>“Intrinsically rewarding experience. An activity is autotelic if it is done for its own sake, with no expectation of some future reward or benefit.” (p. 20)</td>
</tr>
</tbody>
</table>
Conceptualisation of flow experience
(Guo & Poole, 2009)

• Precursors of flow
  Balance between challenge and skill, clarity of goals and feedback

• Flow ‘proper’
  • Reflective higher-order construct
  • Indicators: mergence of action and awareness, concentration, control, loss of self-consciousness, transformation of time and autotelic experience

• The precursors of flow are mediators of the effect of the person, artefact and task characteristics involved in a particular activity on flow (Finneran & Zhang, 2003)
Flow experience in person-artefact-task model (after Finneran & Zhang, 2003, and Guo & Poole, 2009)
Flow experience in immersive environments

• **Immersive virtual learning environments**
  • offer a particularly appropriate context for assessing flow experience in learners, as they can
  • facilitate constructivist learning through meaningful, highly involving experiences as a result of performing purposeful learning tasks

• **Flow has been demonstrated to be an independent predictor of learning task performance and other outcomes, but**
  • there is a lack of research measuring flow in immersive virtual environments and establishing its sensitivity to learning-task characteristics
  • even though these learning environments have great potential to promote experience-based learning.
Aims

• **Aim 1**: psychometrically evaluate a measurement model of flow experience in collaborative learning within an immersive virtual environment

• **Aim 2**: test hypothesis

  • The precursors of flow experience (challenge and skill, clarity of goals and feedback act) as a mediator of the effects of task constraints and experience on flow in collaborative learning within an immersive virtual environment

• **Analyse data set from a series of collaborative learning activities, in which task constraints and experience were controlled experimentally**
Design and procedure

• Independent variables
  • Task constraints (problem type)
    • More constrained – solve maze
    • Less constrained – solve obstacle course
  • Experience (problem number within a problem type)

• Dependent variables
  • Precursors of flow experience
  • Flow experience

• Practice sessions
• Main sessions
• Details of procedure in Martin, Vallance, Wiz and van Schaik (2010)
Participants

- Four undergraduate students
  - Yokohama National University, Japan
  - 3 male, 1 female
  - Experience with IVE Second Life
- Four postgraduate students
  - Teesside University, United Kingdom
  - 3 male, 1 female
  - No experience with SL, but trained in advance of taking part
Materials and equipment

- Desktop PCs
- MacBook Pro laptop computers
- 3-D world in Second Life
- Lego Mindstorms NXT software version 1.1
- Robots – instructions 8527 of Quickstart-Mindstorms
- Two video cameras to record intra-team communication
- Visual Basic program to measure flow using Guo and Poole’s (2009) psychometric inventory – visual analogue scale
Results – measurement model

• Reliability
  • Factor loadings > 0.70
  • composite reliability > 0.70
• Convergent validity
  • Average variance extracted (AVE) > 0.70
• Discriminant validity
  • Square root of AVE > correlation with remaining constructs
### Results – hypothesis

<table>
<thead>
<tr>
<th>Effect</th>
<th>$\Delta R^2$</th>
<th>$t^a$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.87</td>
<td>68.11</td>
<td>***</td>
</tr>
<tr>
<td>Subject</td>
<td>0.52</td>
<td>12.08</td>
<td>***</td>
</tr>
<tr>
<td>Session</td>
<td>0.19</td>
<td>5.73</td>
<td>***</td>
</tr>
<tr>
<td>Problem</td>
<td>0.06</td>
<td>2.76</td>
<td>**</td>
</tr>
<tr>
<td>Precursors</td>
<td>0.11</td>
<td>3.23</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>0.87</td>
<td>68.11</td>
<td>***</td>
</tr>
<tr>
<td>Subject</td>
<td>0.52</td>
<td>12.08</td>
<td>***</td>
</tr>
<tr>
<td>Session</td>
<td>0.19</td>
<td>5.73</td>
<td>***</td>
</tr>
<tr>
<td>Precursors</td>
<td>0.17</td>
<td>3.96</td>
<td>***</td>
</tr>
<tr>
<td>Problem</td>
<td>0.01</td>
<td>0.83</td>
<td></td>
</tr>
</tbody>
</table>
Discussion - measurement of flow in IVE

- Good psychometric properties
- Reliability, convergent validity and discriminant validity
- Recommend use in research and practice to capture flow experience comprehensively
- Advance over previous attempts at measuring flow in the context of computer-assisted learning
Discussion – hypothesis

- Precursors of flow are a mediator of the effect of task constraints and experience on flow experience
- Partial validation of Finneran and Zhang’s (2003) person-artefact-task model and Guo and Poole’s (2009) research model
- In order to achieve a high level of flow experience, tasks in IVEs should be developed to promote
  - balance of challenge and skill
  - clarity of goals
  - Feedback
Discussion – hypothesis (continued)

• With more constrained problems (with less inherent challenge) flow decreased over time learners became less involved
• However, with less constrained problems flow was more variable – perhaps reflecting more inherent challenge
• Need to constantly monitor learners’ flow level (see also Pearce et al., 2005) and adjust learning tasks where appropriate
Future work

- Quality of psychometric flow measurement as a function of user-interface characteristics such as screen layout (e.g. van Schaik & Ling, 2007)
- Comprehensively model flow experience in learning activities
  - mediation of the effect all factors (person, artefact and task) in the PAT-model on flow experience by the precursors of flow
  - in immersive virtual environments
  - in other types of computer-based interactive environment
Conclusions and acknowledgements

• In IVEs for learning flow experience can be comprehensively measured (both flow proper and its precursors) with good psychometric properties
• The precursors of flow are mediators of the effect of problem characteristics on flow
• Contribution to the measurement of and the testing of hypotheses regarding learning in immersive virtual environments
• The research was supported by
  • the UK Prime Minister’s Initiative (PMI2) and
  • the Japan Advanced Institute of Science and Technology (JAIST)