Flow Experiences in Learning to Use a Spreadsheet Application

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Abstract
This paper explores the features of flow experience when learning a spreadsheet application. In addition, the goal is to examine whether and how the flow experience impacts on learning outcomes and what is the relationship between flow experience, learning outcomes, and perceived usefulness. The participants of this study were 116 university students attending a spreadsheet course on a voluntary basis. The data analysis was conducted using structural equation modelling. The results show that the elements of flow experience in this context are similar to those of Csikszentmihalyi, such as, balance between skills and challenges, the clarity of goals, concentration, time distortion, and enjoyment. Furthermore, the flow positively impacts learning outcomes. Surprisingly, learning outcomes is not directly affected by perceived usefulness.

Keywords: Flow experience, Learning outcomes, Perceived usefulness, Spreadsheet application, Structural equation modelling

1. Introduction

In the past three decades, technology adoption has been one of the most popular research areas in information systems (IS) science. The focus has shifted from organizational settings to wide audience end-users. A considerable amount of recent research has focused on the continuance of the use instead of the intention to use new technologies. In addition, most studies have examined full adoption instead of partial adoption. Less attention has been paid to the nature of the adoption, i.e. how users use technologies; can they replicate, adapt or innovate when using information technology; are they satisfied with using only the limited, general features of the entire application, thus adopting the technology only partially?

A multitude of prior studies on technology adoption argues that intention to use new technologies or intention to continue to use technology is seen as a direct antecedent of actual behavior. The theoretical background of these adoption studies has evolved around the Technology Acceptance Model (TAM) developed by Davis [1, 2]. TAM posits that technology adoption intention is predicted by perceived usefulness (PU) and perceived ease of use (PEOU) of the particular technology. After its initial introduction, TAM has been developed further by adding external variables [3], or combining with other theories, e.g., the Unified Theory of Acceptance and Use of Technology (UTAUT) [4], and the Diffusion of Innovations Theory [5].

A fundamental concept in this study is flow, which was first presented in 1975 by Csikszentmihalyi [6]. He has defined flow in many articles and writings later. One definition describes flow to be dynamic: flow is a subjective and optimal experience; something that a person makes happen [7]. The most extensive definition of flow by Csikszentmihalyi consists of eight major features such as balance between skills and challenges, clear goals, immediate feedback, concentration on the activity, time distortion, rewarding activity, the merge of action and awareness, and the decreasing of self-consciousness [8]. This study uses six features of them. We define flow as follows: flow is a state, where a person works with total involvement. She knows the goals of her activity, skills and challenges are in balance, and she sees her task interesting and is focused on her activity feeling time distortion.

In this study, we adopt the construct of perceived usefulness from TAM. However, instead of intention we use learning outcomes as the dependent variable. The core in learning outcomes is learning transfer. Byrnes [9] defines learning transfer as the ability to extend what has been learned in one context to new contexts. By using learning outcomes as the dependent variable it is possible to measure the quality of adoption – the quality of learning.

Past research that adopt TAM, extended TAM or combined TAM and flow theory has examined Internet
use behavior [10], online shopping [11, 12], the effects of online learning [13, 14] and users' involvement in online game playing [15, 16], among others. Although it has been shown that flow experience increases learning, only few studies e.g. Ghani and Deshpande [17] and Pilke [18] have been made in the context of learning to use traditional software such as a spreadsheet application.

Our aim in this paper is to explore the effect of flow experience in learning to use a spreadsheet application. To reach this purpose, users’ perceptions of flow experiences, perceived usefulness and learning outcomes are measured. Firstly, we will examine what are the antecedents of the flow experience in this context. Secondly, our goal is to examine whether and how the flow experience affects learning outcomes. Finally, we will study the relationship between flow experience, learning outcomes, and perceived usefulness.

The data for this study was collected from 116 university students attending a spreadsheet course on a voluntary basis in the fall of 2010. Structural equation modelling was used for analysing the data. The results of this study indicate that the students have flow experience when learning to use a spreadsheet application and that affects learning outcomes. Surprisingly, the perceived usefulness has no direct impact on learning outcomes.

The structure of the study is as follows. In the second section, the literature on flow theory and its relationships with learning outcomes and perceived usefulness is discussed. In the third section, we describe the research setting. The results of this study are presented in the fourth section. In the last section, we discuss our findings, draw conclusions and suggest thoughts for further research.

2. Theoretical background

In this section, we discuss the key concept of the paper, i.e. flow experience (FE), and its relationship with learning outcomes (LO) and perceived usefulness (PU). In addition, based on earlier research the hypotheses and the research model are presented.

2.1. Flow experience

Csikszentmihalyi presented a theoretical model of flow experience in 1975. According to this model, flow describes a state of complete immersion or engagement in an activity. Later Csikszentmihalyi created a unified model for the flow theory integrating motivation, personality, and subjective experience. This optimal experience has been described comprehensively in many of his articles and other writings. The basic idea in the flow theory is that the feeling varies from boredom to anxiety and flow depending on the balance between skills and challenges. The flow experience is possible when both skills and challenges are in balance. One tries to stay at the flow zone by exercising the more challenging tasks (see Figure 1).

![Figure 1. Growth of Complexity Through Flow](image)

A typical, new activity starts with low skills and challenges (A). When the skills increase the activity gets boring (B). At this point, one wants to grow the challenges to return to flow (C). This cycle is repeated through points D and E at higher levels of complexity. These cycles can continue almost forever. Thus, the flow is dynamic by nature.

Csikszentmihalyi’s research and personal observations have identified altogether eight major features in the state of flow [7]:

1. A balance between challenge and skill.
2. Clear goals.
3. Immediate feedback.
4. Distractions are excluded from consciousness.
5. The sense of time becomes distorted.
6. The activity becomes rewarding in itself.
7. Action and awareness merge.
8. Self-consciousness disappears.

The majority of flow related studies use only some of these features simultaneously.

Several techniques have been used to measure flow experience. The earliest flow studies were made using the Experience Sampling Method (ESM) [20, 21]. The ESM method consists of sending the same questionnaire to the participants repeatedly at random times during their activity. The ESM questionnaires contain both categorical and scaled items validated by Csikszentmihalyi and Larson [22]. The categorical items are aimed at reconstructing activity and its social
context. The scaled items aim to measure the intensity of perceived subjective feelings [23]. The other method to measure flow experience used in most studies is single measuring.

2.2. Interdependencies between flow, learning outcomes, and perceived usefulness

The core in learning outcomes is learning transfer. Byrnes [9] defines learning transfer as the ability to extend what has been learned in one context to new contexts. Only a few studies have examined the relationships between flow experience and learning outcomes. Choi et al. [24] and Ho et al. [13] found a positive relationship between these constructs. Both studies found that flow experience has direct and indirect impact via attitudes on learning outcomes. Yet, the features used for flow experience were different. In the ERP study of Choi et al. [24] the factors of flow were quite instrumental such as learner interface, interaction, instructor’s attitude towards students, and the contents of the course. The study of Ho et al. [13] adopted the classification from Trevino and Webster [25] that includes four elements: feel of being in control, focusing attention on activity, feeling curiosity, and having intrinsic interest. Despite the different elements of FE, however, consistent with prior studies about the relationship between flow experience (FE) and learning outcomes (LO), the first hypothesis is defined as follows:

H1. Flow experience affects learning outcomes.

Perceived usefulness (PU) was originally defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [1, 2]. According to the Technology acceptance model (TAM) [1, 2], PU and perceived ease of use (PEU) are the beliefs that impact positively the intention to use new technologies. A multitude of studies have shown PU to be the most important belief influencing intention to use information technology [1, 2, 26-29]. In addition, many studies have indicated PU to be an antecedent of continuance intention [11, 14, 30-33]. The impact of usefulness on learning outcomes might be analogous to the above mentioned studies based on intention and continuance intention. This leads to the second hypothesis:

H2. Perceived usefulness has a positive impact on learning outcomes.

A multitude of studies has indicated the relationship between perceived usefulness and one or more features of flow. In the World Wide Web context, Agarwal and Karahanna [10] argued that cognitive absorption, which is a multi-dimensional construct having the conceptual similarity with Csikszentmihalyi’s flow state, has a positive impact on perceived usefulness. Saade and Bahli [12] found cognitive absorption to be a predictor of perceived usefulness in their Internet-based learning study. Also Shang et al. [34] found a positive relationship between these constructs in their study of on-line shopping. In addition, the e-learning services study of Roca et al. [35] supported a relationship between these constructs. Although all these studies have been made in the web-context, we believe that this is true also in the learning context. So we define the third hypotheses as follows:

H3. Flow experience has a positive impact on perceived usefulness in the learning context.

2.3. Proposed research model

Based on prior research discussed above and relations hypothesized between the three key constructs, we formulate the following research model in Figure 2. The model is based on flow theory (FE) [8], TAM (PU) [1, 2], and learning outcomes (LO) [9].

![Figure 2. Proposed research model](image)

3. Research method

We studied the phenomenon of flow in the context of learning through a survey for the students attending a spreadsheet course at the Aalto University School of Economics (Aalto ECON). In this section we present the course, the Fundamentals of Personal Computing (FPC), and discuss the instrument development and data collection processes.

The empirical data for this study was collected during fall 2010 from students enrolled to six parallel spreadsheet courses. The spreadsheet course is a part of the Fundamentals of Personal Computing (FPC)
course that has been tailored to the needs of business university students at the Aalto ECON. The course is compulsory for all Bachelor level students as part of their Professional Skills Portfolio. FPC introduces ICT tools that are necessary in studies and later at work: spreadsheets (MS Excel), word processing (MS Word), presentation graphics (MS PowerPoint), information search (Journals database in the university library), and reference management (RefWorks). The course focuses on the advanced features of these tools and their utilization in studies and work life.

Even though it is possible to pass the course through a proficiency test, the majority (75%) of students take part in the voluntary contact teaching lessons. Most participants were freshmen. The size of each group was 40 students on average. Every student had a computer available and the teaching method was learning by doing. The teaching language was Finnish.

The teaching of the spreadsheet part includes also the fundamental features of the program. The program used was MS Excel 2007. The Excel-session was taught so that it first consisted of 12 contact hours, and then 12 hours of individual working. The total duration of this voluntary course was seven weeks and the Excel part lasted three weeks.

### 3.1. Instrument development

For our data collection, a web survey using Webropol 2.0 was designed. Measurement scales for our variables were taken from earlier studies, with modified wordings to adjust them to our topic. In this study, flow experience (FE) consists of six features adapted from Csikszentmihalyi [8]. Learning outcomes (LO), in turn, were adapted from Gray and Meister [36]. LO consists of three dimensions; cognitive replication (LR), adaptation (LA), and innovation (LI). Perceived usefulness (PU) was adapted from TAM [1, 2]. However, in our study the target is not the tool, but learning to use it.

The research model consisted of three constructs that included altogether 11 dimensions. The dimensions of learning outcomes were replication (LR), adaptation (LA), and innovation (LI). The features (dimensions) of flow experience were balance between skills and challenges (BA), goal (GO), concentration (CO), time distortion (TI), and enjoyment (EN). Perceived usefulness (PU) included three items (dimensions), i.e. performance (PU01), productivity (PU02), and efficiency (PU03).

The construct of goal (GO), i.e. the clarity of the goals, was measured with school grades (4-10) that were rescaled to 1-7. The constructs of CO and EN were measured using a seven-point semantic differential scale anchored from positive to negative adjective pairs. The other constructs were measured using a seven-point Likert scale validated in the earlier studies. All constructs used with scaled items are available in Appendix 1.

According to Csikszentmihalyi [8], the state of flow experience consists of eight features. In choosing the features, we attempted to take into account our investigation context – learning to use a spreadsheet application in a face-to-face classroom setting. We adopted five features listed by Csikszentmihalyi. The most important feature to reach flow experience may be the balance between skills and challenges. Many researchers have pointed out the importance of this balance [23, 37-39]. Hence, we have the combined variable balance (BA). The scales were adapted from Wu and Liang [40].

Clear goals and immediate feedback help in reaching flow state. However, these features have been used only in few studies [18, 37]. In this study we used the variable goal (GO), which was measured by school grades (4-10). Feedback was not requested. The students get quick feedback due to the teaching method, learning by doing. They all learn together by doing calculations. When a student gets a different result from the trainer’s demonstration, she notices it immediately and asks “what is wrong with my formula or with my chart?”.

Concentration, time distortion, and enjoyment also seem to be quite often used variables in flow studies. The flow state always requires concentration that therefore has been used in several flow studies [23, 37, 41]. In this study the concentration construct (CO) is adopted from Ghani and Deshpande [17]. Time distortion construct (TI) in turn was adapted from Wu and Liang [40] and enjoyment (EN) from Ghani and Deshpande [17].

In addition, we collected information about the general computing skills (CS) and spreadsheet skills (ES) of the participants. All these constructs were measured using school grades (4-10). The self-evaluations on SC and SS were collected before and after the Excel-part of the course.

The questionnaire was first reviewed by a small group of IS faculty at the Aalto ECON and the item wordings were modified according to received suggestions. Then the questionnaire was tested by a small group of doctoral candidates. The test again resulted in some further modifications to the scale item wordings.
3.2. Data collection

The data was collected electronically immediately after the Excel part using the Webropol 2.0 survey tool. 120 responses were received; four responses were discarded due to missing data. Finally, 116 responses were accepted for the analysis.

4. Results

In this section we present the empirical findings of the survey. First, we present the descriptive statistics. Second, we describe the data regarding changes in skills before and after training. The main focus of the analysis is to discover the interdependencies between flow experience, perceived usefulness and learning outcomes, and describe the structure of the research model in detail. For that purpose the instrument’s validity is estimated and a structural model is used to conduct a path analysis and to test the hypotheses in the proposed research model.

4.1. Demographics and skills

The demographic data of the respondents is presented in Table 1. Fifty-two percent (52%) of the respondents were male and forty-eight percent (48%) female. The majority (97%) of the respondents were young adults.

Table 1. Descriptive statistics

<table>
<thead>
<tr>
<th>Construct</th>
<th>Classification</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>60</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>56</td>
<td>48</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;16</td>
<td>113</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>16-26</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>27-36</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>37-46</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>47-56</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;57</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The measurements of general computing skills (CS) and Excel skills (ES) before and after training were compared using the paired t-test (see Table 2). Perceptions of general computing skills increased from 7.71 to 8.04 (t=6.15, p<0.0001) and those of Excel skills from 5.38 to 7.07. (t=17.61, p<0.0001). Hence, the respondents’ perceptions about their both skills have developed positively over time. The course seems to be efficient from the learning point of view. In addition, based on the survey results, it was motivating to notice that the respondents’ perceptions about their general computing skills grew while learning Excel, despite the short duration of the course.

Table 2. Changes in skills before and after training

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Before Mean</th>
<th>Before S.D.</th>
<th>After Mean</th>
<th>After S.D.</th>
<th>Difference Mean</th>
<th>T-statistic</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>116</td>
<td>7.71</td>
<td>0.99</td>
<td>8.04</td>
<td>0.80</td>
<td>0.34</td>
<td>6.15</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ES</td>
<td>116</td>
<td>5.38</td>
<td>1.26</td>
<td>7.07</td>
<td>1.03</td>
<td>1.69</td>
<td>17.61</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

It is notable that almost 32 percent of the respondents had not used spreadsheet applications before the course and over 80 percent of the participants evaluated their own skills to be six or less (with school grade 4-10).

4.2. Measurement model

The instrument’s validity (see Appendix 1) was estimated in terms of internal consistency, and convergent and discriminant validity [42]. Internal consistency was tested using Cronbach’s alpha. All constructs displayed an alpha value between 0.73 and 0.96, indicating reliability on the common acceptable level [43]. The instrument’s discriminant and convergent validity were evaluated using principal component factor analysis of Orthogonal varimax with Kaiser normalization rotation. All measurement items used showed loadings higher than 0.50 on their respective factors, thus proposing the instrument exhibited acceptable convergent and discriminant validity.

However, to keep our model simple, we used multi-item measures only in the construct of PU. The dimensions of FE and LO each consisted of one item (feature). Among others Drolet and Morrison [44] argue that one-item constructs are not necessary harmful.

4.1. SEM-analysis

Structural equation modeling (SEM) was applied to test the causal hypotheses presented in the research model. We examined the model’s goodness of fit, overall explanatory power, and hypothesized causal links using Amos 19.0. The analysis method was maximum likelihood. The SEM approach integrates both observed and latent variables. In the proposed
model, perceived usefulness (PU) and learning outcomes (LO) are endogenous (dependent) variables. Flow experience, in turn, functions as an exogenous (independent) variable.

Firstly, we evaluated the overall goodness fit of the model by using six different fit criteria: the Chi-square statistic divided by the degrees of freedom, comparative fit index (CFI), adjusted goodness of fit (AGFI), normalized fit index (NFI), and root mean square error of approximation (RMSEA).

The results of our analysis and the recommended acceptance criteria for different goodness of fit indices are presented in Table 3. The fit measures show that the structural model represents an excellent fit for the collected data.

<table>
<thead>
<tr>
<th>Table 3. Fit-test of the research model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fit index</strong></td>
</tr>
<tr>
<td>( \chi^2 / \text{degree of freedom} )</td>
</tr>
<tr>
<td>GFI</td>
</tr>
<tr>
<td>AGFI</td>
</tr>
<tr>
<td>CFI</td>
</tr>
<tr>
<td>NFI</td>
</tr>
<tr>
<td>RMSEA</td>
</tr>
</tbody>
</table>

Secondly, the overall explanatory power of the model was measured by using the \( R^2 \) values for the two dependent variables. The flow experience construct explained 41 percent of the variance observed in students’ perceptions of usefulness. Moreover, flow experience explained 80 percent of the variance in students’ learning outcomes.

Finally, the two hypothesized causal paths of the research model, hypotheses H1 and H3, were supported. Flow experience had a direct positive relationship to learning outcomes with the standardized path coefficient being 0.90. Flow experience, in turn, had a positive relationship to usefulness with 0.64. The hypothesized path between perceived usefulness and learning outcomes was insignificant, and hypothesis H2 was therefore rejected.

Based on the SEM analysis that is presented in Figure 3, hypotheses H1 and H3 were supported, and hypothesis H2, surprisingly, was not supported. Thus, flow experience in this study consists of five supposed features. Also learning outcomes seem to have three dimensions (cognitive replication, adaptation, and innovation). Perceived usefulness does not impact directly on learning outcomes as expected. The impact of flow experience on learning outcomes is undisputable.

**Figure 3. The results of SEM-analysis**
5. Summary and Conclusions

In this study we explored the feelings and experiences of students participating in a spreadsheet course. The aim was to examine flow experience when learning the use of a spreadsheet application. In more detail, we wanted to find out the features of the flow experience in this learning context. Our main interest was to consider how flow experience impacts learning outcomes and what kind of role perceived usefulness may have in this context.

The findings of this study suggest that the students who participated in these spreadsheet courses had flow experiences, which in turn affected learning outcomes. The role of perceived usefulness was a surprise. It was expected that PU is an important, direct antecedent to learning outcomes based on adoption theories [1, 2]. However, flow experience had an impact on perceived usefulness. These findings suggest that PU might be added as a feature to flow experience. Or perceived usefulness might have a moderating effect enlarging the flow zone.

This study also showed that learning was quite efficient. The respondents evaluated their spreadsheet skills and general computer skills before and after the course - the results show that both skills increased significantly during the course.

These findings have both theoretical and practical contributions. Our study provides a new utilitarian construct, perceived usefulness, to the flow theory that has been seen more as hedonic in nature. Thus, perceived usefulness might enlarge the flow zone. Practical contributions are related to learning arrangements. It is important to create learning environments where skills and challenges are in balance to keep the learners on “the flow channel”. It might also be possible to use tasks that generate an increasing flow cycle. In addition, the task should have a clear goal, and naturally it should be interesting. Finally, as Csikszentmihalyi [7] argues, “flow is something we make happen”. We have to create learning environments, where learners can actively participate and learn by doing, and get immediate feedback.

While this study provided interesting findings about the relationships between flow experience, learning outcomes and perceived usefulness, it has limitations. The study examined and reported the participants’ feelings and experiences after the spreadsheet course. To get more just in time measurements, the Experience Sampling Method (ESM) or biometrical methods during the task execution could be used, for example. Maintaining the flow state is a continuous challenge in learning.

References


### Appendix 1

#### Table 4. Measurement items
(The italicized items are not analyzed, the italicized items with * are dropped due to inconsistent alpha values)

<table>
<thead>
<tr>
<th>Item</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following questions ask about your feelings while learning to use Excel. Please describe a typical Excel-session by placing check marks on the scales given below:</td>
<td></td>
</tr>
<tr>
<td><strong>CO – Concentration, Ghani and Deshpande (1994): Cronbach’s alpha = 0.83</strong></td>
<td></td>
</tr>
<tr>
<td>CO01: I was deeply engrossed in Excel activity … Not deeply engrossed</td>
<td>0.85</td>
</tr>
<tr>
<td>CO02: I was absorbed intensely in Excel activity … Not absorbed intensely</td>
<td>0.84</td>
</tr>
<tr>
<td>CO03: Attention was focused on Excel activity…Attention not focused</td>
<td>0.69</td>
</tr>
<tr>
<td><strong>EN – Enjoyment, Ghani and Deshpande (1994): Cronbach’s alpha = 0.88</strong></td>
<td></td>
</tr>
<tr>
<td>EN01: Learning to use Excel is interesting … Not interesting</td>
<td>0.70</td>
</tr>
<tr>
<td>EN02: Learning to use Excel is fun … Not fun</td>
<td>0.80</td>
</tr>
<tr>
<td>EN03: Learning to use Excel is exciting … Dull</td>
<td>0.77</td>
</tr>
<tr>
<td><strong>TI – Time distortion, Wu and Liang (2011):Cronbach’s alpha = 0.93</strong></td>
<td></td>
</tr>
<tr>
<td>TI01: Time seems to pass quickly when learning to use Excel (Strongly disagree…Strongly agree)</td>
<td>0.85</td>
</tr>
<tr>
<td>TI02: I tend to lose track of time when learning to use Excel (Strongly disagree…Strongly agree)</td>
<td>0.88</td>
</tr>
<tr>
<td>TI03: Learning to use the versatile functions of Excel makes me feel time distortion (Strongly disagree…Strongly agree)</td>
<td>0.84</td>
</tr>
<tr>
<td><strong>CH – Challenge, Wu and Liang (2011) (BA=balance between skills and challenges): Cronbach’s alpha = 0.73</strong></td>
<td></td>
</tr>
<tr>
<td>CH01: Learning to use Excel challenges me (Strongly disagree…Strongly agree)</td>
<td>*</td>
</tr>
<tr>
<td>CH02: Learning to use Excel challenges me to do my best (Strongly disagree…Strongly agree)</td>
<td>0.75</td>
</tr>
<tr>
<td>CH03: Learning to use Excel gives me a multitude of challenges to win (Strongly disagree…Strongly agree)</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>LR – Cognitive replication, Ho and Kuo (2010), Gray and Meister (2004): Cronbach’s alpha = 0.89</strong></td>
<td></td>
</tr>
<tr>
<td>LR01: I am able to apply what I learned in the spreadsheet course at studying and work (HO and Kuo (2010))</td>
<td>*</td>
</tr>
<tr>
<td>LR02: I understand much better now the right way to use Excel than before the course (Strongly disagree…Strongly agree) (Gray and Meister (2004))</td>
<td>0.82</td>
</tr>
<tr>
<td>LR03: I know much more now about the right ways to work with Excel compared with earlier. (Strongly disagree…Strongly agree) Gray and Meister (2004)</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>LA – Cognitive Adaptation, Ho and Kuo (2010), Gray and Meister (2004): Cronbach’s alpha = 0.81</strong></td>
<td></td>
</tr>
<tr>
<td>LA01: I am able to adapt what I learned in the spreadsheet course in studies and at work to improve my working effectiveness and efficiency (Strongly disagree…Strongly agree) (Ho and Kuo)</td>
<td>*</td>
</tr>
<tr>
<td>LA02: I want to upgrade my Excel knowledge also in the future (Strongly disagree…Strongly agree) (Gray and Meister (2004))</td>
<td>0.79</td>
</tr>
<tr>
<td>LA03: I want to upgrade my Excel skills also when it gets new features (Strongly disagree…Strongly agree) (Gray and Meister (2004))</td>
<td>0.80</td>
</tr>
<tr>
<td><strong>LI – Cognitive innovation, Ho and Kuo (2010), Gray and Meister (2004): Cronbach’s alpha = 0.78</strong></td>
<td></td>
</tr>
<tr>
<td>LI01: I am able to find a new way of doing my job based on what I learned in the Excel course (Strongly disagree…Strongly agree) (Ho and Kuo (2010))</td>
<td>*</td>
</tr>
<tr>
<td>LI02: I can use innovatively the provided Excel functions (Strongly disagree…Strongly agree) (Gray and Meister (2004))</td>
<td>0.50</td>
</tr>
<tr>
<td>LI03: I am eager putting to the test new features of Excel (Strongly disagree…Strongly agree) (Gray and Meister (2004))</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>PU – Perceived usefulness, Davis (1989) : Cronbach’s alpha = 0.96</strong></td>
<td></td>
</tr>
<tr>
<td>PU01: The skills provided by Excel course increase my performance (Strongly disagree…Strongly agree)</td>
<td>0.87</td>
</tr>
<tr>
<td>PU02: The skills provided by Excel course increase my productivity (Strongly disagree…Strongly agree)</td>
<td>0.90</td>
</tr>
<tr>
<td>PU03: The skills provided by Excel course improve my efficiency (Strongly disagree…Strongly agree)</td>
<td>0.90</td>
</tr>
</tbody>
</table>

The items used in the SEM analysis are as follows: Concentration CO=CO01, Enjoyment EN=EN02, Time distortion TI=TI02, Balance between skills and challenges BA=CH03, Cognitive replication LR=LR03, Cognitive adaptation LA=LA03, Cognitive innovation LI=LI02. The items were chosen based on the best loadings. In addition, all items of perceived usefulness (PU), PU01, PU02, PU03 were chosen. Furthermore, Goal GO that was measured using school grades (4-10) and converted to the scale 1-7 was used in the SEM-analysis.