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Comparing Dropout in Short-Duration Further Education Classroom and E-learning Courses in Computer Programming

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ABSTRACT OF THE
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The main research question in this thesis concerns how much dropout – meaning not completing a course – does happen related to short, commercial e-learning courses in the field of professional software development, and what are the main reasons.

To shed light on the phenomenon, two additional aspects were considered. Firstly, the classroom and e-learning instruction formats were compared using several existing theories. Secondly, also the dropout regarding classroom-based courses was investigated.

Dropout in classroom was examined in a two-phase mixed methods study. The first phase concentrated on how the students were able to complete the exercises of the courses. In the latter phase interviews were used to corroborate the findings and to learn more of classroom dropout.

Dropout in e-learning was analysed in three mixed methods phases. In the initial phase the e-learning platform recorded how students navigated in the content. Interviews were later conducted about the reasons behind the students' usage behaviour. Finally, a survey was formed based on the interviews to uncover what could be done to minimise dropout.

The study of dropout in classroom showed that dropout is a rare phenomenon, laying in the vicinity of five percent. The interviews revealed that even then the participants were happy with the part of the content that was learned. Inadequate prerequisite knowledge was by far the most major concrete reason for dropout.

In the e-learning part of this research the dropout was 80%, with a variation of ±8%. Understandably lack of time was the most cited reason for dropout. Also interesting were the findings about what could be done to minimise dropping out of a course. General advantages of e-learning, like the ability to choose when to study, were seen to be of major importance – this supports the view that e-learning plays an influential part in contemporary further education. Of the aspects related to course content and the e-learning environment, noteworthy are content that adapts to the skills and interests of the student, feedback about progress and learning, and a pleasant user interface. Interestingly, social aspects like communication or competition, or supervising done by the teacher did not gather strong support. Of the external factors, dedicated studying time from work was felt as influential.

Keywords: e-learning, classroom, adult education, further education, programming education, dropout, student attrition, persistence

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Tämän opinnäytteen päätutkimuskysymys on keskeyttämisten määrä ja syyt verkko-opetuksessa. Keskeyttäminen tarkoittaa tässä yhteydessä sitä, että kurssia ei suoriteta loppuun. Tutkimus on rajattu koskemaan lyhyitä, kaupallisia verkkokursseja liittyen sovelluskehittäjien ohjelmointiosaamisen kehittämiseen.

Jotta ilmiöstä saataisiin laajempi näkemys, verrattiin luokka- ja verkko-opetusta opetusmuotoina hyödyntäen olemassa olevia teorioita, sekä tutkittiin luokkamuotoisessa opetuksessa tapahtuvaa keskeyttämistä.

Luokkaopetuksen keskeyttämistä tarkasteltiin kaksivaiheisessa monimenetelmätutkimuksessa. Ensimmäinen vaihe keskittyi siihen, kuinka opiskelijat pystyivät suorittamaan kurssien harjoitukset loppuun. Myöhemmässä vaiheessa opiskelijoita haastateltiin tarkoituksena vahvistaa löydöksiä ja saada lisää tietoa keskeyttämisestä ilmiönä.

Verkkokurssien keskeyttämistä tutkittiin kolmessa monimenetelmätutkimuksen vaiheessa. Alkuvaiheessa verkko-opetusympäristö tallensi opiskelijoiden liikkumisen sisällössä. Tämän jälkeen haastatteluilla selvitettiin syitä sille, miksi opiskelijat käyttivät sisältöä tietyllä tavalla. Haastattelujen vastausten pohjalta rakennettiin kyselytutkimus, jolla selvitettiin miten keskeyttämistä voitaisi vähentää.

Luokkaopetukseen liittyvä tutkimus osoitti, että keskeyttäminen on harvinainen ilmiö: viiden prosentin luokkaa. Haastattelut paljastivat, että näissäkin tapauksissa opiskelijat olivat tyytyväisiä opittuun osaan sisältöä. Suurin syy keskeyttää kurssi oli esitietojen riittämättömyys.

Verkko-opetuksessa keskeyttämisprosentti oli $80 \pm 8\%$. Yleisin syy keskeyttää oli ymmärrettävästi aikapula. Keskeyttämisten vähentämiseen liittyi mielenkiintoisia löydöksiä. Yleiset verkko-opetuksen edut, kuten mahdollisuus valita opiskelun ajankohta, nähtiin hyvin tärkeiksi – tämä tukee näkemystä siitä, että verkko-opetuksella on merkittävä rooli aikuiskoulutuksessa. Kurssin sisällön ja oppimisympäristön piirteistä huomionarvoisia olivat opiskelijan taitoihin ja mielenkiinnon kohteisiin mukautuva sisältö, järjestelmän antama palaute edistymisestä ja oppimisesta sekä miellyttävä käyttöliittymä. Mielenkiintoista kyllä, sosiaalisia seikkoja kuten keskustelumahdollisuutta tai kilpailullisia piirteitä ei pidetty tärkeinä, eikä myöskään opettajan tekemää edistymisen valvontaa. Ulkoisista seikoista merkityksellisenä pidettiin mahdollisuutta käyttää työaikaa opiskeluun.

Avainsanat: verkkokurssi, verkko-opetus, luokkaopetus, aikuisopetus, sovelluskehityskoulutus, keskeyttäminen

Preface

I wish to express my sincerest gratitude to my supervisor, professor Lauri Malmi, for all the aid I received when entering the world of education research. In my opinion the level of support was the most fitting, as I could get an answer even to questions of small minutiae, but on the other hand I could freely try my wings when I felt that I could manage on my own. I still cannot fathom how he could find the time to help even with the components of the classroom data collection user interface, let alone perusing thoroughly through the thesis several times over. Without his aid the work would have been lesser.

I would like to thank my advisor PhD Päivi Kinnunen very much for all her answers to the flow of questions, for all the advice during the research design and execution phases, and especially for her the time spent reading and commenting the manuscript. The introduction to the qualitative and mixed methods delivered by her had an uniquely positive influence to the structure of the research. From her I also got a memorable example of how an inspiring and motivating classroom course can be conducted.

Without the encouragement from my wife Outi Tarvainen the work would never have happened. She helped me through the most intense part of the studies for the degree, and spent hours and hours by reading through the various text summaries produced at that time. Thank you for making this unforgettable experience a possibility!

My employer at the time of conducting the data collection for the study, Sovelto Oyj, gets my thanks for giving me valuable hours off the work in order to be able to conclude the studies for the degree. The aid from Sovelto was also invaluable in getting to conduct the actual research with its customer base, i.e. the actual students.

Finally I offer a deep bow to the grandparents for helping me to find time for writing by taking care of the boys of the family, Santtu and Tuukka, so that they would not suffer from the hours spent with the computer. Thank you all!

Espoo, 27.4.2017

Panu Korpela

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Terminology

Adult education "Systematic learning undertaken by adults who return to learning having concluded initial education or training" [75, p. 27]

Affect "The conscious experience of an emotion." [26] "Any state that represents how an object or situation impacts a person." [30, p. 1185]

Attrition See *dropout*

Blended learning Learning that combines classroom and online features

Cognition Mental activities related to thinking, knowing, remembering, and communicating [99, p. 174]

Cognitive learning Cognitivist approach explains learning as the learner using a success to think differently about the situation by making a holistic structural reorganisation of it, thus allowing a link to be made between the action and its consequence [73, p. 47]

Collaborative learning Collaboration between students as a process of learning *adds* to social constructivism the idea of experiential learning that requires the learner to produce an output by acting on the world in some way [73, p. 57]

Constructivist learning Understanding is gained through an active process of creating hypotheses and building new forms of understanding through *activity* [89, p. 9]. It accentuates the belief that meaning is *constructed* actively, rather than simply assimilated in a passive manner [123, p. 246].

Dropout The phenomenon of not completing a course. For discussion about the definition in classroom instruction see subsection 2.5.1 on page 24, and for further analysis about the definition in the context of e-learning see subsection 2.6.1 on page 33.

E-learning "Learning facilitated and supported through the use of information and communications technology." [53] For discussion about the term see also subsection 2.4.3.1 on page 11.

Epistemology Knowledge: its nature and forms, how it can be acquired, and how communicated [21, p. 6]

Further education "Further education is everything that does not happen in schools or universities" [62, p. 1]. Also called *lifelong learning*, or in the United States *continuing education* [130, p. 116]. See also *tertiary education* and *adult education*.

Online learning See *e-learning*

Ontology The nature of reality and the nature of things [21, p. 3]; "what exists"

Persistence Completing a course. The opposite of *dropout*.

Retention See *persistence*

Schema An organised body of information about some distinct domain of knowledge [123, p. 248]. A concept, or mental mould into which experiences are poured [99, p. 174].

Situative learning A learner will always be subjected to influences from the social and cultural setting in which the learning occurs, which will also define at least partly the learning outcomes [89, p. 9]

Social constructivist learning Also called socio-constructivist learning [80, p. 9]. The approach argues that learning through discussion is important, and distinct from learning through practice, because the act of articulating an idea is itself a contribution to what it means to know that idea [73, p. 49]

Tertiary education Tertiary education refers to all post-secondary education, including but not limited to universities [151]

1 Introduction

1.1 Background

Demand for more highly educated employees has risen for the past four decades [100, p. 50] and thus further education has become more and more relevant [43]. Commercial training companies are one of the providers of such training in the format of short courses with a typical duration between one to three days. As e-learning[1] has gained ground in all kinds of training [2, 115] it can be assumed that its role will grow also in the mentioned short course format.

High attrition of e-learning – or of distance education as a more general phenomenon – has been a major problem for some decades, and as such a subject of multiple studies [7, 128, 76]. In adult further education delivered in the e-learning format the attrition percentages have been reported to be around $70-80\%$ [55]. Furthermore there is anecdotal evidence that the percentage can be even higher when the subject being taught is not directly the occupation of the learners. For example, in one short commercial further education course of 5000 learners in spring 2012 in Finland only 500 completed the training, rendering the dropout at 90%.

Unfortunately as the literature review of this study shows, almost all of the studies concern long courses that are typical in school or university surroundings. Research related to short courses (usually 1–5 days in duration) commonly used in the business community has mostly been absent.

1.2 The context of the study

1.2.1 Short classroom-based courses

Sovelto Oyj, a Finnish commercial training company, has provided instruction in various computing related subjects since late nineties. The format of the courses has been classroom instruction with a duration of less than a week, most commonly 1–3 days. The amount of students on a course is relatively low, typically between 4 and 16 students.

About half of the courses delivered by the company are public, delivered at a certain date, and about half are customer-specific. The latter ones are held either at a customer's premises or in Sovelto's own classrooms.

These short courses differ from for example university style courses in several additional important aspects. Firstly, any time expenditure is expensive, not only as the course price is considered, but also as the students are not creating revenue for their employers when being absent from work. This is the major force behind the limited course duration. Secondly – in the target group of this study – the students are computing professionals, and as such have at least some existing knowledge about the subject areas. Thus in many subjects the focus can be in best practices, or in the "big picture" rather than in the minutiae of a given technique, or in remembering the pieces of information provided for a long time. In other words, using the well-known Bloom's *Taxonomy of educational objectives* [9, p. 204], the level of the courses is commonly on the *comprehension* level, whereas university courses using a lot more time can aim

[1] In this study the e-learning is delivered entirely online.

for deeper levels of understanding and applicability[2]. Thirdly, the short duration of the course itself is a differentiator. Most noticeably social features – intra or extra-curricular – remain largely absent. Fourthly, given the small group size, the teacher has the means of adapting the course content to the level of the students. How much can be adapted depends on the promises given in the course description, or in what has been promised to a customer when company-specific courses are considered.

In this study the classroom-based courses were delivered by four teachers including the researcher. The teachers and the courses that they held when data was collected for this study are introduced in Appendix D on page 152.

1.2.2 E-learning adoption

The evident likeliness of a high dropout rate had raised concerns at Sovelto – my employer in 2012 – which was considering adopting e-learning after providing aforementioned further education classroom-based courses for a long time. For the students, a great problem of classroom-based training is timeliness, as it may take months before a certain classroom course is given. As such there exist understandable anecdotal evidence that customers – both people and companies – are less and less inclined to wait for long periods of time in order to get the training that they need due to expansion in the offering of various online resources or e-learning courses.

1.2.3 Short e-learning courses

The short length of the courses act as an interesting motivator for the study, as a large meta-analytical study in e-learning professional education [128, p. 644] found that online course participants gained more knowledge relative to classroom instruction as the length of the class increased, hinting that creating short e-learning courses may be more problematic than creating longer ones.

In a journal article called "Factors influencing adult learners' decision to drop out or persist in online learning" [109] it had been found that in longer courses the following aspects have been influential in student dropout: external support of the family or of the organisation, learner satisfaction, relevance to the work assignments, and prior knowledge and experiences. It can be assumed that the aspects are somewhat different for shorter courses, as for example family will not be much affected by a course of only some days. Also it is interesting to analyse more deeply the aspects – for example satisfaction and relevance – that can be affected by changing the course than the external factors of for example age, family responsibilities, or life crises.

1.2.4 The target group of the study

In this research the focus group consists of programming professionals learning new aspects related to their work, such as programming languages, libraries or other software development techniques. The programming skills being taught form a central part of the occupation of the subjects.

[2]For a more thorough treatise on the taxonomy levels see subsection 4.4.1 on page 50.

1.2.5 Defining dropout

In the case of formal education[3], the definition of dropout may seem straightforward – a course or a degree has either been passed or not. However there is more variability, as for example a student may transfer to another, maybe more demanding institution [110, p. 203]. Or it is possible that the student already knows everything present on the course [143]. Lately Massive Open Online Courses (MOOCs) have accentuated this aspect, as typically there is no credit given for the completion of MOOC courses [2, p. 12] and students thus may learn to pay less weight on the credits than the actual knowledge gained.

In the case of this study the definition of dropout was at least as problematic as in formal education, and can almost thought of to be a research question in itself. Eventually it was decided to give certain definitions for a quantitative phase in the classroom and e-learning versions, but to further analyse the phenomena as mixed method studies via interviews and a survey.

1.2.6 Problems caused by dropout

Dropout often concerns multiple parties, and as such the problems caused by it can be viewed from several perspectives. For example in the case of formal education, apart from the student, dropout may affect the faculty personnel, the institution, or even the society.

In the case of programming professionals dropout can be seen as problematic to the programmer and the employer if the knowledge delivered is needed in software projects. Unfortunately in many cases – instead of learning – programmers may resort to "coding by Google", which eventually takes more time, or a programmer may for example re-create code already found in a language's libraries thus wasting time and moreover introducing new possibilities for programming errors.

Dropout is also problematic for the course provider. Very low completion percentages lead to a high likelihood of the customers abandoning the purchase of online courses altogether if the benefits of online training are seen as minimal, or if competing commercial or non-commercial course offerings are seen as having similar or better value.

1.2.7 Limitations caused by the course setting

The classroom courses under scrutiny were commercial and relatively highly priced. This caused two noteworthy limitations. Firstly, no major time-consuming changes to the courses could be made. For example tests measuring learning would be out of the question – on the other hand, given the comprehension target level mentioned above, such tests would probably have little utility. Secondly, any questionnaires or similar that would accentuate possible deficiencies of a course setting could not be targeted to every student, so as not to needlessly drop the satisfaction felt by them.

[3]Degree-granting, for example university education.

1.3 The research question

The main research question concerns **how much dropout does happen related to short e-learning courses in the field of professional software development, and what are the main reasons**.

In order to enlighten the typification of dropout percentages of e-learning as "very high", or "higher than in classroom" there should be an understanding of what the dropout is in classroom instruction in these types of courses. The situation of short courses is after all noticeably different from traditional formal semester-long courses as discussed above.

Thus the main question has been split into two subquestions:

RQ 1: What is the dropout in classroom-based courses? What are the main reasons for dropout? This gives at least a ballpark figure that the e-learning dropout can be compared with. There is a great difference in the pricing of classroom-based (typically over 500 euros per day) and e-learning courses (from free to dozens of euros a day), which can be assumed to affect the motivation of the learners. As the difference is an unchanging feature of both the course types, they can still be compared.

RQ 2: What is the dropout in e-learning courses? What are the main reasons for dropout?

1.4 Research setting

1.4.1 Comparison of classroom and e-learning instruction

The first part of the study consists of a theory based comparison of classroom and e-learning instruction. This is necessary so that the later parts of study can be conducted by knowing what is being compared.

1.4.2 Classroom dropout

Classroom dropout part in this study has two distinct phases:

1. Analysis of dropout by inspecting students in the classroom
2. Interviews to find out more about the dropout phenomenon

1.4.3 E-learning dropout

The e-learning dropout part is divided into three phases:

1. Analysis of dropout by inspecting e-learning usage of the students
2. Interviews to find out more about the dropout phenomenon, with a focus on features that can be altered in the course content or in the e-learning platform
3. A web-based survey to uncover the relative importance of the features of the e-learning course content or the e-learning platform that may affect the dropout phenomenon

In the case of this study it is important to note that in order to get enough students for the e-learning course, the content of the course was chosen to be the JavaScript language, which was a prerequisite for many classroom courses. As such the use case does deviate from a situation where the e-learning course would cost money. On the other hand, using e-learning for covering gaps in prerequisites is also a genuine way of using the technology within the target company, and so the research setting follows real-life usage.

2 Theoretical foundation

2.1 Structure of the section

Aside from

- the description about conducting the *literature review* in subsection 2.2,
- presenting the *philosophical views* underlying the study in subsection 2.3 on page 8, and
- giving further reasons for performing the study in analysing *why dropout is a problem* for various parties in subsection 2.7 on page 35,

the theoretical handling is divided to two major views:

1. *Presentation* of the theories:
   (a) *Differences* between classroom and e-learning instruction (subsection 2.4 on page 10)
   (b) Dropout in *classroom* instruction (subsection 2.5 on page 24)
   (c) Dropout in *e-learning* instruction (subsection 2.6 on page 33)
2. *Analysis* of the short course situation in the light of these three theory sets (section 3 on page 37)

2.2 Conducting the literature review

2.2.1 Initial literature review

The first version of literature review was made in an ad hoc style, in order to find more about the study questions. In order to reliably show that no other studies in the same field had been made, special attention was later given to a more thorough literature review [36, 149].

2.2.2 Subsequent journal selection

The second literature review was started by consciously choosing the journal databases as shown in Table 1 on the following page.

Table 1: Journal databases of the literature review

Database	Link	Suggester
ACM	http://dl.acm.org/	[68]
PsycARTICLES (ProQuest)	http://search.proquest.com/psycarticles/	[36, p. 17]
ScienceDirect	http://www.sciencedirect.com/	[36, p. 17]
IEEE Xplore	http://ieeexplore.ieee.org/	[68]
ERIC (ProQuest)	http://eric.ed.gov/	[36, p. 16]
Education Journals (ProQuest)	http://search.proquest.com/education/	[102]
JSTOR	http://www.jstor.org/	[102]
Applied Social Sciences Index and Abstracts (ProQuest)	http://search.proquest.com/assia/	[102]
SAGE journals	http://jec.sagepub.com/	[102]
EBSCOhost Academic Search Elite	https://www.ebscohost.com/	[102]
Google Scholar	https://scholar.google.com/	common knowledge

Furthermore, the thesauri of the databases were used, if one was found. The final search terms varied mostly between "e-learning" / "electronic learning", "adult education" / "continuing education" / "corporate" / "workspace", and "dropout" / "attrition" / "persistence" / "retention". The full terms and results are listed online in a spreadsheet at `http://bit.ly/1S573lr`.

2.2.3 Article selection

The search gave 93 articles for e-learning dropout and further 53 articles for classroom dropout from a total of 71 different journals. Quickly perusing the articles did show that there was considerable variation in the quality. So a practical screening criterion [36, pp. 51–52] had to be created and used. First a *Journal Impact Factor* (JIF) was found for all the journals that were listed in Thomson Reuters' journal database [137]. Unfortunately only 28 journals could be found in the database – less than a half of all the journals containing the articles. Furthermore the JIF has faced considerable criticism during the past years; see for example [13].

2.2.3.1 The g index A well-cited alternative to JIF has been Hirsch's h index [49], which can be calculated by each researcher herself. For this study a variation of the h index called g index [31] was chosen as the g index gives more weight to highly cited papers and matches the original JIF more closely [11, p. 1472]. The g indices were calculated using a separate software package "Publish or Perish" version 4.19 [46].

To see if the JIF and the g index are correlated in this case, the correlation was checked using the SPSS 23 statistical package. A simple linear regression was calculated to predict the Journal Impact Factor based on the g index. A significant regression equation was found, ($F(1, 26) = 34.599$, $p < .000$), with an R^2 of .571, suggesting a large effect size [20]. The predicted Journal Impact

Factor is equal to $.922 + .002 \cdot (g \text{ index})$. A graph can be seen in Figure 1 on the next page.

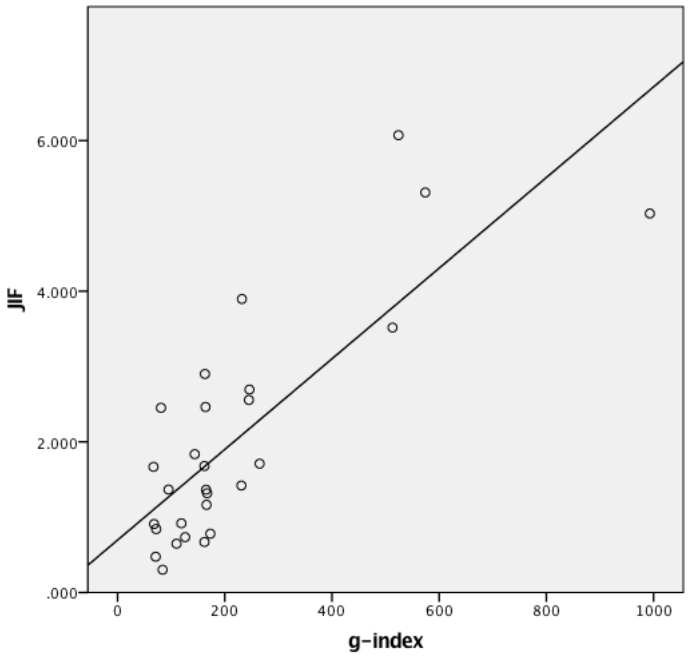

Figure 1: Journal g index and Journal impact factor (JIF) correlation

2.2.3.2 Article selection limits The articles found were read in the order of the g indices of the journals, and in the order of the citation count of individual articles when a journal contained several of them. In order to limit the huge number of articles, only peer-reviewed journals with a g index of 100 or more and citation count of three or more were read – in total 54 articles. Also individual articles with a citation count of 50 or more were read, although this added only five more documents – showing that the limit in the g index very successfully chose also the most cited articles.

2.3 Ontological and epistemological assumptions

2.3.1 Philosophical orientation

In the study a *mixed methods*[4] approach was used. The motive behind the choice is treated later in subsection 4.3 on page 50.

The philosophical orientation most often associated with mixed methods is *pragmatism*, defined as:

> philosophical position that what works is what is important or "valid" [54, p. 591]

[4]Better called "methodologies", but the term "methods" has been retained as its use is more established [136, p. 21].

> A deconstructive paradigm that debunks concepts such as "truth" and "reality" and focusses instead on "what works" as the truth regarding the research questions under investigation. Pragmatism rejects the either/or choices associated with the paradigm wars, advocates the use of mixed methods in research, and acknowledges that the values of the researcher play a large role in interpretation of results. [136, pp. 7–8]

> There is a concern with applications – what works – and solutions to problems. Instead of focussing on methods, researchers emphasise the research problem and use all approaches available to understand the problem. As a philosophical underpinning for mixed methods studies, Morgan [96], Patton [112], and Tashakkori and Teddlie [136] convey its importance for focussing attention on the research problem in social science research and then using pluralistic approaches to derive knowledge about the problem [23, pp. 10–11].

Regarding epistemological assumptions, in pragmatism *knowledge* is viewed as [54, p. 431]:

> being both constructed *and* based on the reality of the world we experience and live in (original italics)

> endorses fallibilism: current beliefs and research conclusions are rarely, if ever, viewed as perfect, certain, or absolute

> views current truth, meaning, and knowledge as tentative and as changing over time

Thus in using mixed methods the underlying philosophy necessarily somewhat subscribes to the post-positivist view of the world – otherwise conducting quantitative research would be meaningless (the problem is also stated in [86, p. 147]). This is not in direct conflict with the pragmatist view, but it is worth mentioning.

2.3.2 Ontological assumptions

Regarding the ontological assumptions of this study, the view is a pragmatist one leaning towards the critical realism of post-positivism (that is, an external reality that is understood imperfectly and probabilistically [136, p. 88]). Thus the belief is that there exists a collection of major reasons for dropout, but the opinions of the students will colour the responses to a degree when they are interviewed.

2.3.3 Epistemological assumptions

Considering the epistemological assumptions, they vary between the objectivist and the subjectivist point of view depending on the stage of the research cycle [136, p. 88]. The view has also been called *practicality* [24, p. 42], where for example researchers collect data by "what works" to address research questions. More precisely within the quantitative phases the view is objective, where

knower and known are independent – a dualism [136, p. 86]. During the qualitative phases the view leans towards a subjective point of view where reality is co-constructed with participants. In other words, in this view the knower and known are interactive, inseparable [136, p. 88].

2.4 Differences between classroom-based and e-learning courses

2.4.1 General

There have been a huge number of studies that compare classroom and e-learning courses, stemming especially from the long tradition of study of distance education [7, 128, 76]. The results are varying, but on the whole there is no great difference in the effectiveness between classroom and e-learning education, being in agreement of Clark's argument [18] that instructional methods rather than delivery media determine learning outcomes. Examples of such research are:

- University education: Online students consistently perform better than the face-to-face students [22]
- University adult education: Students studying purely online appeared to perform slightly better than those following a blended route [15][5]
- Further education: Both groups demonstrated the same learning outcomes – the dropout rate was lower in the e-learning participant group [50]
- Meta-analysis containing further distance education: Distance education had slightly better achievements, classroom had slightly better student attitudes, and classroom had slightly better student retention [7]
- Community and technical college: Performance of online students suffered in all subjects, except for education, mass communication, and health and physical education. Online was more suited to better students. There was noticeable variation between course subjects – the social sciences (for example anthropology, philosophy, and psychology), the applied professions (e.g. business, law, and nursing), mathematics, humanities, and the English language showed the largest differences in performance. In contrast to these, aforementioned education, mass communication, health and physical education had an insignificant effect. Additionally natural sciences and computer science had a small effect [152].
- University: No difference in knowledge retention [113]
- Further education (meta-analysis): No difference in effectiveness or satisfaction. E-learning was more suited for older participants and longer courses [128].

[5] Not a randomised study

2.4.2 Factors of a learning environment

A picture containing the various levels of analysation, based on the *Community of inquiry* theory [38], inspired by [92], is shown in Figure 2 on the next page. The model agrees with the framework presented by Piccoli et al. [116], a systems theoretical view of nested systems in distance education [122, p. 60], and additionally with the various theories presented in the subsections below. The picture is added here to shed light on the many factors involved in a learning situation.

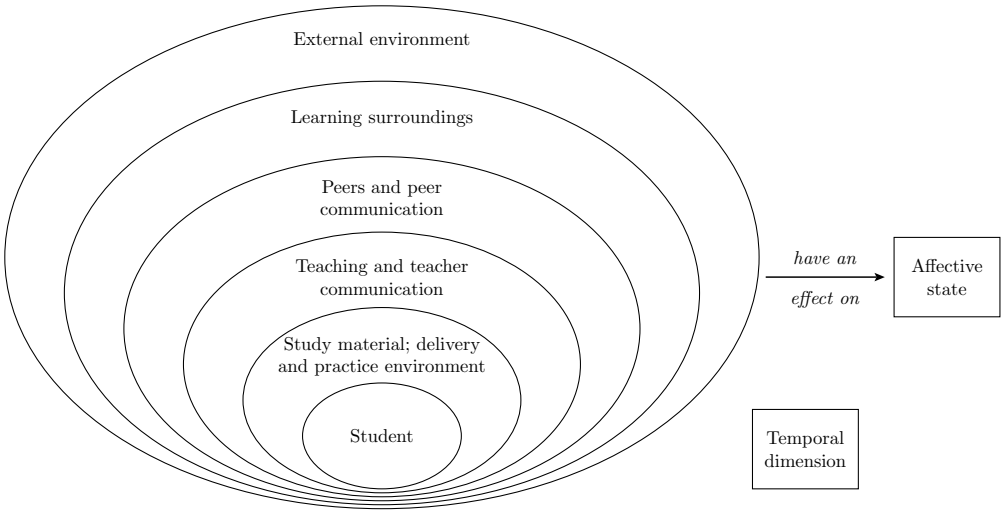

Figure 2: Factors of a learning environment

The theories used in this study for the comparison of classroom and e-learning instruction have been chosen so as to cover all the features depicted in Figure 2. For example cognitivist theories [101, p. 8] would not cover the social aspects, the environment, or the affective state.

2.4.3 Feature differences

2.4.3.1 Online education compared to other forms of study The main elements of *online education* when compared to other forms of study have been listed as [118, p. 7], based originally on an earlier definition of distance education [59]:

1. the quasi-permanent separation of teacher and learner throughout the length of the learning process (this distinguishes it from conventional face-to-face education);

2. the influence of an educational organisation both in the planning and preparation of learning materials and in the provision of student support services (this distinguishes it from private study and teach yourself programmes);

3. the use of computers and computer networks to unite teacher and learners, and carry the content of the course;

4. the provision of two-way communication via computer networks so that the student may benefit from or even initiate dialogue (this distinguishes it from other uses of technology in education); and

5. the quasi-permanent absence of the learning group throughout the length of the learning process so that people are usually taught as individuals rather than in groups, with the possibility of occasional meetings, either face-to-face or by electronic means, for both didactic and socialisation purposes.

Given the rise of collaborative learning scenarios, the last point is no longer necessarily true in all contexts [118, p. 8].

Alternative, shorter definitions simply state that:

> Online education implies instruction through a connection to a computer system at a venue distant from the learner's personal computer. [69, p. 568]

> Web-based instruction is hypermedia-based instructional program which utilises the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported. [63, p. 6]

> Learning facilitated and supported through the use of information and communications technology. It can cover a spectrum of activities from the use of technology to support learning as part of a "blended" approach (a combination of traditional and e-learning approaches), to learning that is delivered entirely online. [53]

The first one of these accentuates the division between the learner and the source of the content. The second one on the other hand concentrates on the possibilities that may be offered by the content being web-based.

And as highlighted the third definition, a strict division between classroom and online education is not necessarily true. As an example of the variability in the usage of online features, Table 2 shows the definitions used for over a decade in a report series on online education in the United States [2].

Table 2: Traditional and online course classifications (repeated from [2, p. 7])

Proportion of content delivered online	Type of course	Typical description
0%	traditional	Course where no online technology used – content is delivered in writing or orally.
1% to 29%	web facilitated	Course that uses web-based technology to facilitate what is essentially a face-to-face course. May use a learning management system (LMS) or web pages to post the syllabus and assignments.
30% to 79%	blended / hybrid	Course that blends online and face-to-face delivery. Substantial proportion of the content is delivered online, typically uses online discussions, and typically has a reduced number of face-to-face meetings.
80 + %	online	A course where most or all of the content is delivered online. Typically have no face-to-face meetings.

All of the definitions above corroborate the fact that differences do indeed exist between classroom-based and online education, and thus for their part justify the analysis of this section.

As a final note, in this study the focus in the context of e-learning is on courses where all the content is delivered online.

2.4.3.2 Types of e-learning

Synchronous and asynchronous e-learning Distance education can be either group based and time and place dependent, or individually based "in which students in remote locations work independently or in asynchronous groups, usually with the support of an instructor or tutor" [7, pp. 386–387]. The former one has been termed *synchronous distance education* and the latter *asynchronous distance education* [4, 7]. Also the terms *cohort-based* and *self-paced* have been used in the context of MOOCs[6] [48, p. 86].

Online learning has primarily begun as an asynchronous activity, but has more recently with the introduction of various Web 2.0 technologies seen an advancement in synchronous versions [67, p. 177].

Differences in interaction The approaches can furthermore be differentiated by analysing which facets of the instruction are interacting with each other [93, 1, 6]:

[6]MOOC = *Massive Open Online Course*

1. Learner–content interaction
2. Learner–instructor interaction
3. Learner–learner interaction

In complete agreement of these categories three major types of e-learning courses have been suggested [44, pp. 87–88]:

1. The most basic type is *Online courseware* (OC), or *Online computer-based training*, defined as: *"OC refers to the use of courseware (pre-packaged content) that a learner accesses online. The learner uses an individualised self-paced pedagogy to interact with the courseware content, which is presented in a modular format."* Most importantly OC does not have instructor or peer interaction. OC has also been called *self-directed e-learning* (SDEL) [64] or *computer-aided instruction* (CAI) [116, p. 403]. Using the categorisation from the previous subsection, the OC model is by nature asynchronous.

2. In *Online distance education* (ODE) a correspondence model of course delivery is used; the major difference to OC is an added tutor support. The ODE model can be either asynchronous or synchronous. The decision on the synchronicity is likely be based on the availability of tutors.

3. The third category is called Online collaborative learning (OCL) with the following definition: "*OCL refers to educational applications that emphasise collaborative discourse and knowledge building mediated by the Internet; learners work together online to identify and advance issues and understanding, and to apply their new understanding and analytical terms and tools to solving problems, constructing plans or developing explanations for phenomena.*" Another term for the approach is *virtual learning environment* (VLE) [116]. The OCL model is typically synchronous – in an asynchronous version it would be difficult to organise the exercises so that there are enough participants present at any given time.

The implications of the three models – single study, teacher presence, and teacher and peer presence – and how the teaching differs from classroom-based education can be analysed using Laurillard's *Conversational framework* as it shows how many times an educational type encourages the student to process a given component of a subject. Choosing this framework was inspired by [1, p. 85] as well as expert suggestion [131]. The framework itself is introduced in the next subsection.

2.4.3.3 Theories for comparison: Laurillard's *Conversational framework* Laurillard's well-validated [150, p. 7] *Conversational framework* [73, 71, 72] has been devised to combine and represent several formal descriptions of learning so that teaching design can benefit from all those insights. Some background and clarifying depictions of the formulation and the structure of the framework are included in Appendix A on page 138.

The framework sees the role of *the teacher* to motivate the internal cycles that generate and modulate the learner's *concepts* and *practice*, which facilitates learning. And *the learner* interacts with the teaching–learning environment at

two levels: by generating articulations of their concepts, and by acting on the external environment (that is, practicing), and they receive feedback on both.

The framework is shown in Figure 3; the abbreviations used are listed in Table 3 on the next page.

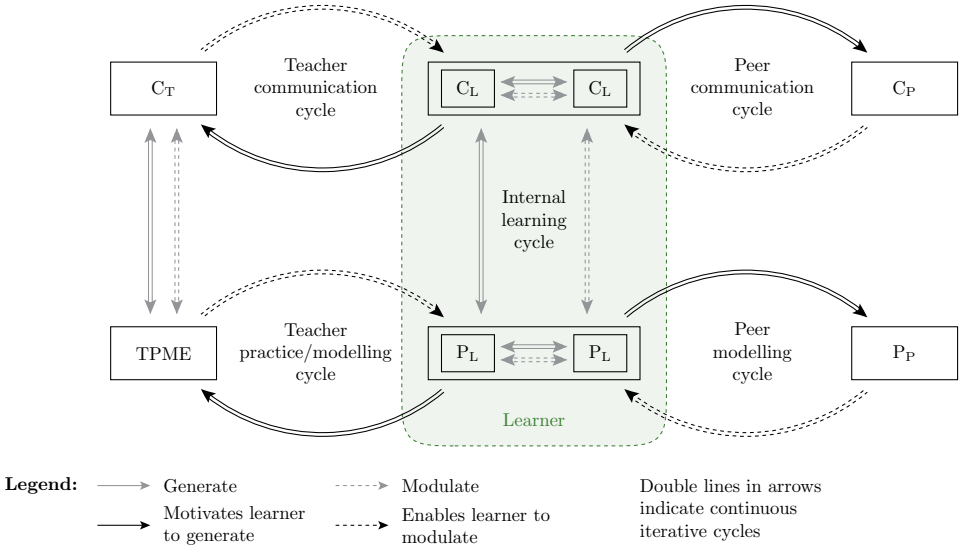

Figure 3: Laurillard's *Conversational framework* (adapted from [73, pp. 92, 95])

Table 3: Legend for abbreviations inside the boxes in Figure 3

Abbreviation	**Meaning**
C_T	Teacher's concepts
C_L	Learner's concepts
C_P	Peer's concepts
TPME	Teacher practice/modelling environment
P_L	Learner's practice capability
P_P	Peer's practice capability

Types of learning and teaching and the Conversational framework Teaching–learning activities that are commonly found in education are *learning through acquisition*, *inquiry*, *practice*, *production*, *discussion*, and *collaboration* [73, pp. 96–97]. These types of activities are listed in Table 4 on the following page, which shows that each one can use various technologies and methods, both conventional and digital. None of the technologies by themselves provide the design elements that would cover all types of teaching–learning activities.

The first four types of learning (acquisition, inquiry, practice, and production) are related to individual learning; discussion and collaboration describe social learning, where at least one peer is involved. Below are elaborated how the Conversational framework represents the types of individual learning most common on the context of this study, that is learning through acquisition and

Table 4: Types of learning and different types of supporting learning technologies

Learning through	**Conventional technology**	**Digital technology**
Acquisition	Reading books and papers; listening to teacher lectures face-to-face; watching demonstrations; master classes	Reading multimedia, websites, digital documents and resources; listening to podcasts and webcasts; watching animations and videos
Inquiry	Using text-based study guides; analysing the ideas and information in various materials and resources; using conventional methods to collect and analyse data; comparing texts, and searching and evaluating information and ideas	Using online advice and guidance; analysing the ideas and information in a range of digital resources; using digital tools to collect and analyse data; comparing digital texts, and using digital tools for searching and evaluating information and ideas
Practice	Practicing exercises; doing practice-based projects, labs, field trips, and face-to-face role-play activities	Using models, simulations, micro-worlds, virtual labs and field trips, and online role-play activities
Production	Producing articulations using statements, essays, reports, accounts, designs, performances, artefacts, animations, models, and videos	Producing and storing digital documents, representations of designs, performances, artefacts, animations, models, resources, slideshows, photos, videos, blogs, and e-portfolios
Discussion	Tutorials, seminars, discussion groups, and class discussions	Online tutorials, email discussions, discussion forums, blog comments, and web-conferencing tools (synchronous and asynchronous)
Collaboration	Small group project, discussing others' outputs, and building joint output	Small group project, using online forums, wikis, chat rooms, etc. for discussing others' outputs, and building a joint digital output

learning through practice.

Learning through acquisition The traditional format of lecturing – learning through acquisition – is shown as analysed with the Conversational framework in Figure 4 on page 17. In learning through acquisition, reading, hearing, or watching an explanation of teacher's concept (or model action) enables the learner to modulate her own concept, and see the teacher's practice. It does not require the learner to generate any action or articulation. Technologies and methods are typically lectures, class presentations, various texts, and videos [73, p. 98].

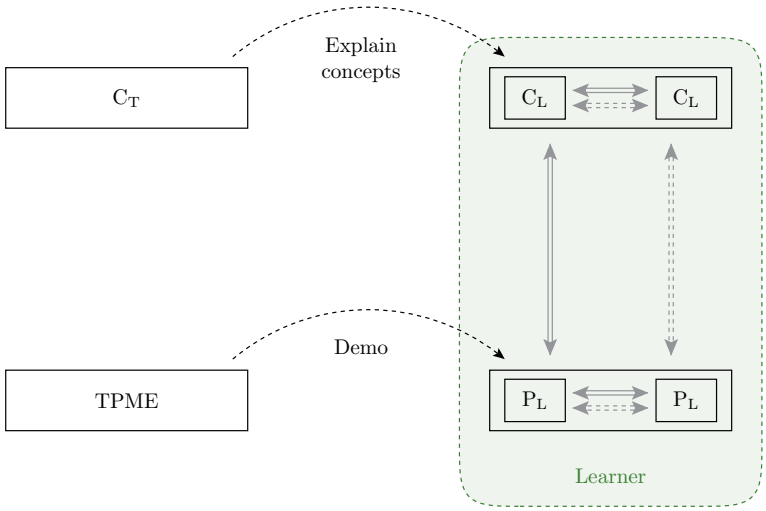

Figure 4: Learning through acquisition (redrawn from [73, p. 97])

Learning through practice The learner is using her developing concepts to improve her action: putting the theory into practice in working towards a goal, generating an action to achieve it, and using the feedback to modulate her action or conception. The role of the teacher is to provide the modelling environment. This is depicted in Figure 5.

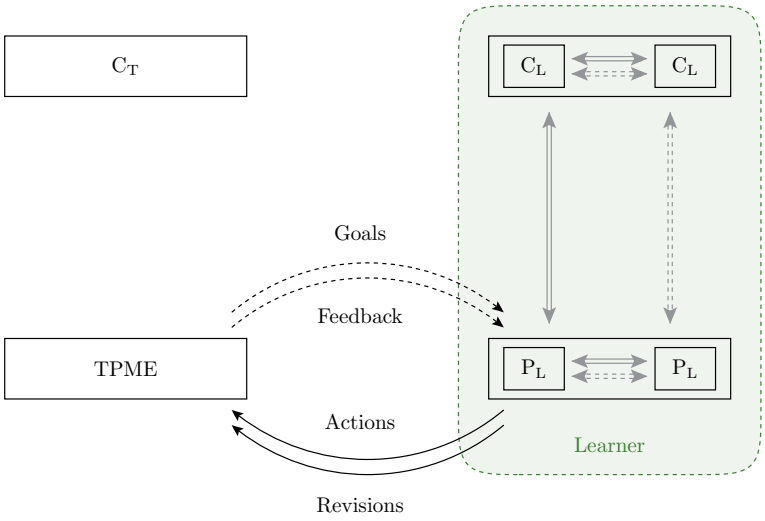

Figure 5: Learning through practice (redrawn from [73, p. 97])

These mappings represent how the *learner* experiences various types of learning.

To summarise: when learning, or its effectiveness is analysed, the Conversational framework guides the analysis in two ways: (1) which cycles or parts of them are active, and (2) how many internal iterations are caused within the learner. The more internal cycles are happening, the more effective the teaching – and subsequently learning – is.

2.4.3.4 Theories for comparison: Cognitive theory of multimedia learning and Cognitive load theory

Cognitive theory of multimedia learning While the Conversational framework goes a long way to see how certain features of instruction cause various iterations of learning to happen, it does not deeply analyse how the features of a lecture are immediately processed by the student. Suggested by [1, p. 90] as well as expert discussion [81], *Cognitive theory of multimedia learning* [87] can be used to find out about the similarities (or dissimilarities) of the classroom-based and e-learning versions of a lecture, so that the limits of comparing them can be understood. The theory is presented in graphical format in Figure 6 on the next page.

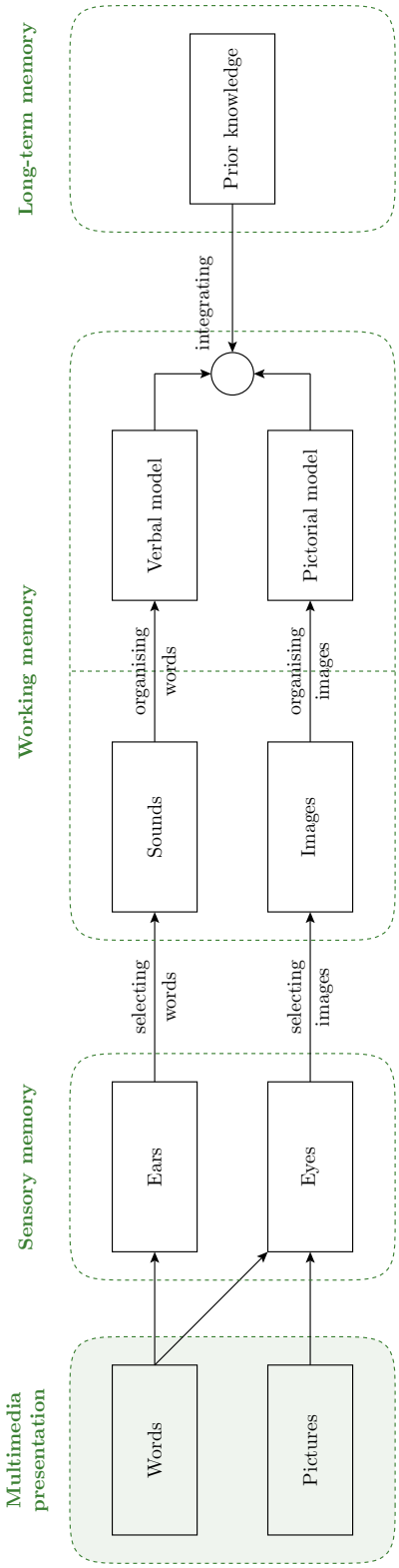

Figure 6: Cognitive theory of multimedia learning (redrawn from [87, p. 37])

The theory firstly assumes that humans process information in working memory through two channels: an *auditory–verbal* and a *visual–pictorial* channel. The second assumption is that the channels have a *limited capability* of information conveying and processing each. Thirdly, it is assumed that humans are *active in sense making* – they use active cognitive processing to construct knowledge structures from the external information available and their prior knowledge.

Essentially, the theory suggests that using a presentation format that utilises both the auditory and visual channels utilises the cognitive capabilities more fully than using only one of them.

Related to instruction, another giveaway of the theory is the *Multimedia principle* [87, p. 47]:

> People learn more deeply from words and pictures than from words alone.

The principle implies that learning that includes verbal explanations (textual or auditory) and corresponding visual depictions will result in more successful learning than learning with only either one of the features.

Cognitive load theory The Cognitive theory of multimedia learning aligns with [51, p. 242] *Cognitive load theory* (e.g. [79, 133], multiple contributions [94]; suggested by [143]), which finds three of loads on cognition: intrinsic, extraneous, and germane. The complexity of a given subject causes *intrinsic load*, which depends on the prior knowledge of the learner, her intellectual abilities, and the complexity of the presented material. *Extraneous load* means unnecessary load caused by an inappropriate instructional format. And finally, *germane load* refers to the amount of invested mental effort [134]. These are depicted in Figure 7 and clarified below.

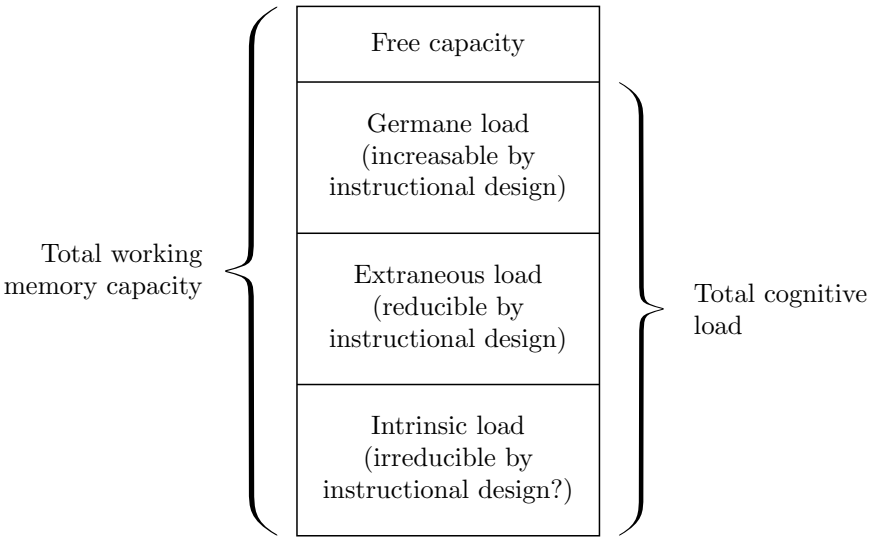

Figure 7: Cognitive load theory (redrawn from [94, p. 18])

In *intrinsic load* the essential factor is *element interactivity*, which means the

number of elements that must be processed simultaneously in working memory in order to be able to understand – and learn – a given subject. It is worth noting that element interactivity cannot be determined by the content alone, as depending on the schemas acquired earlier by the student, a complex material may seem easy enough for some learners. This is facilitated by the notion that a large amount of organised information can be transferred from long-term memory to working memory. In contrast to this only a limited amount of novel information can be organised in a manner promoting change in long-term memory.

A major motivator for Cognitive load theory has been an ability to provide guidelines for reducing *extraneous cognitive load*. The guidelines are based on the five principles (originally [135]) shown in Table 5. Whether an instructional procedure creates extraneous load can be assessed by considering these five principles. For example if teaching relies only on the randomness of genesis principle as contrasted with the borrowing and reorganising principle, or if it ignores the limit of working memory proposed by the narrow limits of change principle, the instruction is likely to be ineffectual.

Table 5: Natural information processing system principles

Principle	**Relates to**	**Description**
Information store	Long-term memory	A human has a basically limitless and fast-functioning long-term memory
Borrowing and reorganising	Transferring information to long-term memory	Most information in long-term memory is borrowed from others. It is however constructively reorganised either at the time of borrowing or later to form schemas.
Randomness of genesis	Creation of new ideas	When knowledge is unavailable, a human is likely to randomly generate new problem-solving moves followed by tests of effectiveness
Narrow limits of change	Novice working memory	The capacity limitations of working memory impose a limit to the number of novel items that can be dealt with
Environmental organising and linking	Expert working memory	Experts can transfer large amounts of organised, schematic information from long-term memory to working memory to perform appropriately in a situation

Freeing available mental resources by reducing extraneous load may not result in increased learning unless the freed resources are redirected to activities related to schema acquisition – this phenomenon has been named as *germane cognitive load*.

According to an additivity hypothesis of the Cognitive load theory the loads are additive as depicted in Figure 7 on the preceding page. According to this, the total load cannot exceed the available working memory resources if learning is to occur.

Expertise reversal effect Last but not least, expertise reversal effect [58] is related to Cognitive load theory, finding that some features of a study environment that help novice students can hinder the learning of experts of the subject.

Basically, learning reduces the limits of working memory (see Figure 6 on page 19) by enabling the use of schemata that are stored in long-term memory, and which help to process information more efficiently. Controlled use of these schemata requires conscious effort and thus also consumes some of the scarce working memory resources. However, after enough practice, schema processing can become automatic. Then only a minimal amount of working memory resources are utilised and problem solving can proceed with little effort.

Instruction that has been designed for novice learners provides instructional guidance that act as a substitute for missing schemata. If properly constructed, the guidance itself uses a minimal amount of working memory.

However if experts use the same material as novices, and are unable to avoid the guidance provided for novices, there is an overlap in information between the experts' own schemata and the redundant instruction-based guidance. Then, it is possible that the expert learner attempts to relate the overlapping components requiring additional working memory resources and even causing a cognitive overload. This may happen even if the learner notices the redundancy and decides to ignore it to the best of her capability.

2.4.3.5 Theories for comparison: The role of affect The Conversational framework and cognitive theories presented in the previous subsections have a shortcoming in that they do not take into account the affective dimensions of studying, although the concept of germane load as invested mental effort does hint to that direction. There is also evidence that affective aspects influence cognition as storage and retrieval of information [10, p. 78]. Wlodkowski's well-cited *Motivational framework for culturally responsive teaching* [147, pp. 112, 126–127, 172, 226, 310][148] (inspired by [64]) lists the four essential conditions as:

Establishing inclusion Creating a learning atmosphere in which learners and teachers feel respected and connected to each other. Adults are community-forming beings, and motivation is constantly influenced by the awareness of the level of inclusion in a learning environment. Establishing inclusion has been noted to work best when planned for the beginning of the course [40, p. 222].

Developing attitude Creating a favourable disposition toward the learning experience through personal relevance and volition. In order for adults to have a positive attitude toward learning, they have to see it as relevant. They also have to see it as an activity to which they respond with free choice, self-determination, or compliance with something that they agree about. It is best to target the actions that facilitate developing attitude for the beginning of the lesson [40, p. 222].

Enhancing meaning Creating challenging and engaging learning experiences that include learners' perspectives and values. To avoid boredom, variety, meaningful challenges, and even some unpredictability is needed.

Engendering competence Creating an understanding that learners are effective in learning something they value. Competence is a powerful motivational condition for adults. It is most suitable to plan this for the ending of the lesson, but with criteria for success set at the start [40, p. 222].

The framework is shown in pictorial format in Figure 8.

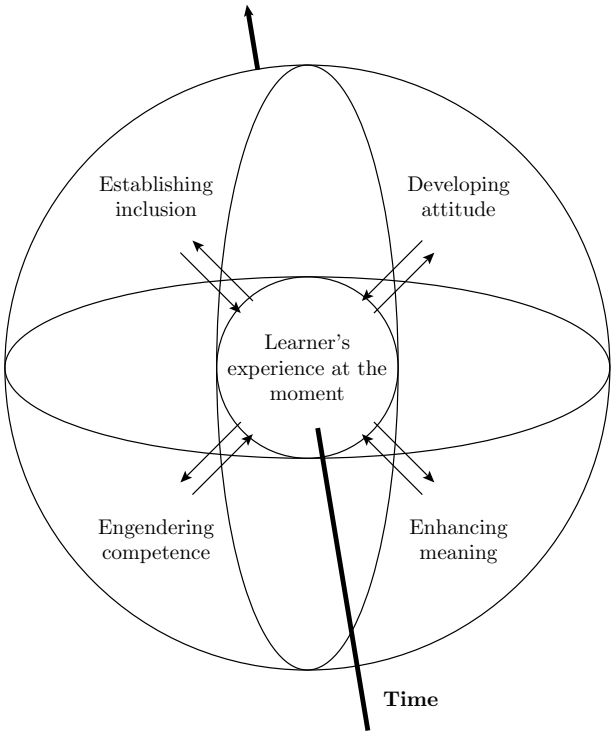

Figure 8: Motivational framework for culturally responsive teaching (redrawn from [147, p. 113])

It is worth noting that the conditions listed above are culturally dependent. For example the participants having a background in an individualist Scandinavian culture – compared to a collectivist culture typical of many parts of Asia – will guide the actual steps of a teacher to establish a given condition [147, pp. 128–134].

2.4.4 Other feature differences

The contemporary *web-based technologies* may carry with them an even larger differentiation from the classroom environment; citing from [50, p. 141]:

> While traditional lecture style face-to-face learning tends to centre on the lecturer, rendering the learner a passive participant, web-based learning has emerged as a learner-centred education modality that facilitates involvement and feedback from the learner. Web-based learning is a learner-centerer system that allows the learner to engage in educational activities as often as they like, whenever they

choose, wherever there is an internet connection. The shift from traditional teaching face-to-face to a web-based environment requires a fundamental shift in pedagogy.

This quotation carries an important message as when the differences of individual aspects are analysed in later sections, the sum of the differences may constitute even a larger effect that the individual pieces suggest.

2.4.5 Closing notes

A revised version of the factors of a learning environment presented in Figure 2 on page 11 is shown in Figure 9. It shows how the theories presented in this section cover the various facets that were previously found to be of importance.

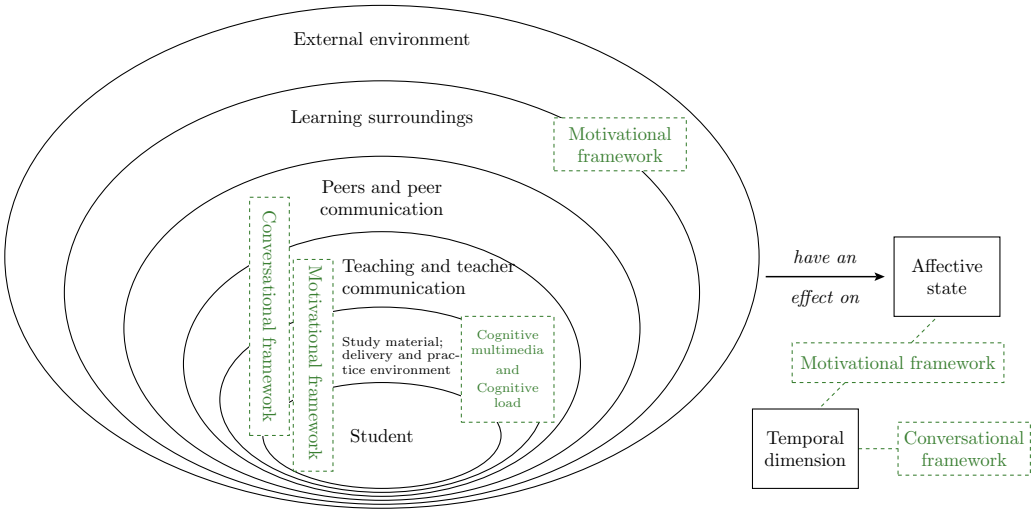

Figure 9: Factors of a learning environment: Theories

2.5 Dropout in classroom-based courses

2.5.1 Definition in other studies

There has been considerable amount of research considering dropout of *classroom* courses in tertiary education [151, 139]. The definition of *dropout*, also sometimes called *attrition* – and sometimes referred to via the contrary terms of *retention* or *persistence* – has a lot of variability, and unfortunately many research papers even fail to define it altogether [76, p. 596]. The following exhaustive list sheds light on the complexity of the phenomenon; quoting from [127, p. 168]:

1. Inquirers who do not register for a course
2. Students who become dormant – they do not withdraw but they do not submit assignments
3. Students who "actively" withdraw
4. Students who submit assignments but do not take the exam

5. Students who fail the exam outright
6. Students who fail for administrative reasons – not paying fees, etc.
7. Students who fail, are allowed to retake examinations and fail them
8. Students who fail, are allowed to retake examinations but do not take them
9. Students who pass one course or module but do not reserve or register for another

In addition to the nine cases listed above a student may simply have an intent to re-roll at a later time [12, p. 581]. Or the student may transfer to another, maybe more demanding institution – this can be named "positive dropout" [110, p. 203]. Or it is possible that the student already knows everything present on the course [143].

It is important to notice the wording on item number 9 above. It highlights the common longitudinal aspect of dropout in university or school settings: dropout in many studies is used to denote not being able to complete a whole degree – not only dropping out of a single course.

Dropout can also be thought of in the wider context of success and failure:

> "Yet it [dropout] may have have positive as well as negative causes and consequences. Thus, learners may leave a course because they judge that their learning needs have been satisfied, or because they have identified another course better able to satisfy them. In such cases, it is not unreasonable to regard dropout as representing a success, from the individual if not the provider's point of view." [138, p. 153]

This leads to the view that dropout research should be careful in giving dichotomous dropout–or–not answers; the aspect warrants more precise scrutiny.

2.5.2 Definition in the case of short courses

In the case of short, commercial courses no formal degrees exist, and examinations commonly related so such degrees are thus also absent. Moreover course sets aiming for a complete command of a subject area are only a minority in the course offering portfolio. Thus while giving a definition for dropout in this case the focus needs to be on a single course. Unfortunately, as mentioned earlier, dropout in these short duration courses has gathered scant research and no ready-made definition for the phenomenon could be found.

The classroom-based courses in this study do not have a test at the end, or any other definite means of differentiating between the dropout or persistence phenomena. Leaving the class altogether would be an authoritative definition, but this is so rare as to be non-existent, and certainly does not pose a problem to be researched.

As a practical hindrance to solving the problem, given the short duration of the courses and high price for the participants' employers, no alterations taking a noticeable amount of course time can be used. Moreover, clearly dropping out of a course could be very stigmatising for the student and thus the fact should not in any way be highlighted – otherwise she or he is unlikely to attend

future courses, which would hinder the business of the target company. For these reasons an examination or other test of capabilities can not be added to the end of the course.

An operationalisable definition will be given in the research setup section 4.4.1 on page 50.

2.5.3 Reasons for dropout

The dropout phenomenon has gathered several models for analysing the reasons for it. The models tend to concentrate on longer, school or university style courses and thus be longitudinal, but they can be trimmed to find out possible causes for shorter courses. Two cited [97] and complementing [14, 119] models are Tinto's *Student integration model* [141, p. 114] (originally [140]; depicted in Figure 10 on the following page) and Bean and Metzner's *Conceptual model of student attrition for nontraditional students* [5] (Figure 11 on page 30).

The graphical depictions of the models are included in this subsection to help better compare them, and in the case of Bean and Metzner's model to make it more understandable as in the original article especially the interactions are very difficult to tell apart.

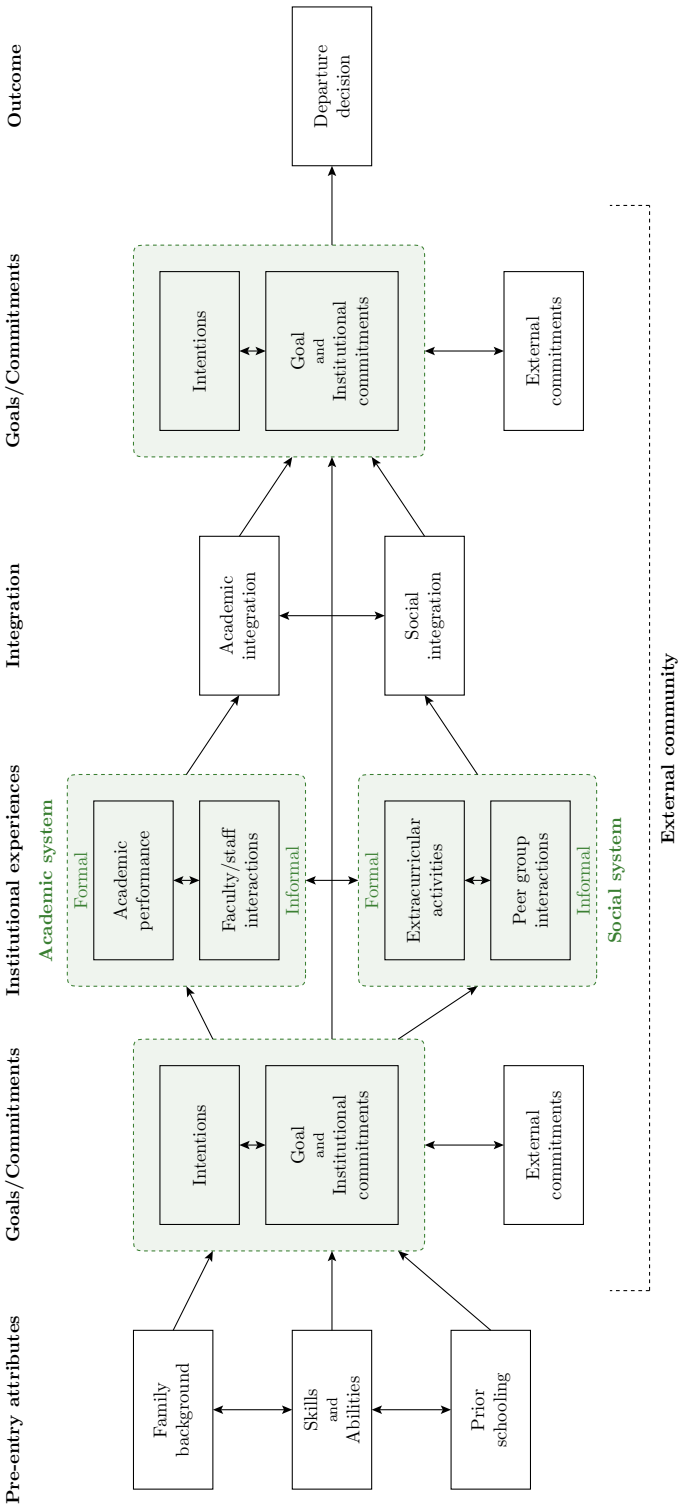

Figure 10: Tinto's *Student integration model* (redrawn from [141, p. 114])

2.5.3.1 Tinto's *Student integration model*

Vincent Tinto's *Student integration model* has been extensively cited and validated in the articles analysed in this study's literature review [110, 111, 39, 60, 76, 143][7], and due to its prominence the model is worth presenting here. The model is also interesting because it has been used to interpret dropout studies in the field of distance education [60, p. 284]. Furthermore, in addition to the original college and university settings, the model has been used in some cases in adult education research [92, p. 142]. This warrants caution however, as adults' cognition, motives, ways how they engage in classroom, and their life-world experiences differ from the college-age students [28, p. 25].

The main features of the model The *Student integration model* focusses on student integration into the educational environment via two channels: academic integration and social integration. These are influenced by academic performance and interaction with faculty and peers. In addition to integration, other salient features in the model include student *background*, clarified below, and *goals and commitments*, also expanded below.

Clarifications of the model graph The *pre-entry attributes* of the model shown as the boxes on the left side of the model are interestingly enough somewhat incomplete in the diagram when compared to the textual clarification of the model [141, p. 115]. In their complete form the pre-entry attributes consist of the following:

- *Family and community background*: For social status, parental education, and size of community
- *A variety of personal attributes*: E.g. gender, race, and physical handicaps
- *Skills*: E.g. intellectual and social skills
- *Financial resources*
- *Dispositions (intentions and commitments)* [141, p. 113]: E.g. motivations; intellectual, social, and political preferences
- *Prior educational experiences and achievements*: E.g. high school grade-point average

Clarifications of the *commitments* [141, p. 115]:

- *Goal commitment*: Degree to which individuals are committed to the attainment of those goals
- *Institutional commitment*: Degree to which individuals are committed to the institution into which they gain entry

Other notes The creator of the model has in a later article mentioned that the model concentrates on the impact the institution has on the dropout behaviours of the students [142]. In this later article the author pays more attention to the pre-entry attributes listed above on this page [142, p. 689].

[7] Variability about the validation understandably remains [12]

2.5.3.2 Bean and Metzner's *Conceptual model of student attrition for nontraditional students*

The *Conceptual model of student attrition for nontraditional students* [5] by John P. Bean and Barbara S. Metzner is derived from traditional student attrition models and behavioural theories, expanded with an extensive review of nontraditional student literature [5, p. 486]. The model concentrates more on the adult student population than Tinto's model and has been used in adult dropout research [84, 39, 92]. It is worth mentioning that also other minorities have been included in the creation of the model, quoting from the original [5, p. 488]:

> Nontraditional students can be from any part of the country; from rural or urban settings; rich or poor; black, white, or Hispanic; 18 years old or older; not employed, working full- or part-time, or retired; male or female; with or without dependents; married, single, or divorced; and enrolled for vocational or avocational reasons in a single course or in a degree or certificate program.

This model deviates from Tinto's model in that it places greater emphasis on the utility of the education, and on the encouragement received from family, friends, and the employer, and less emphasis on the academic integration.

The model concentrates on "commuter students" that do not reside on the campus [5, p. 494], and as such the model is approaching distance education research, while such an aspect is not specifically voiced out.

The model can be thought to have four major categories that are used to predict student persistence [132, p. 156]:

1. *academic variables*, such as study habits and course availability;
2. *background* including age, ethnicity, educational goals, and prior GPA[8];
3. *environment variables*, which include finances, hours of employment, family responsibilities, and outside encouragement; and
4. *psychological variables* such as stress, self-confidence, and motivation, which can impact the ability to complete a study or programme.

It is worth noting that although the model is grounded on a meta-analysis style of dissecting 73 other studies [5, p. 509–519], the authors expressively noted that the model was only a tentative one and needed to be modified when more studies became available [5, p. 530]. The tentativeness assumedly affects the large amount of direct, indirect, and possible effects that have been included in the model, somewhat reducing its readability.

The complete model is depicted in Figure 11 on the next page.

[8] GPA = *Grade Point Average*

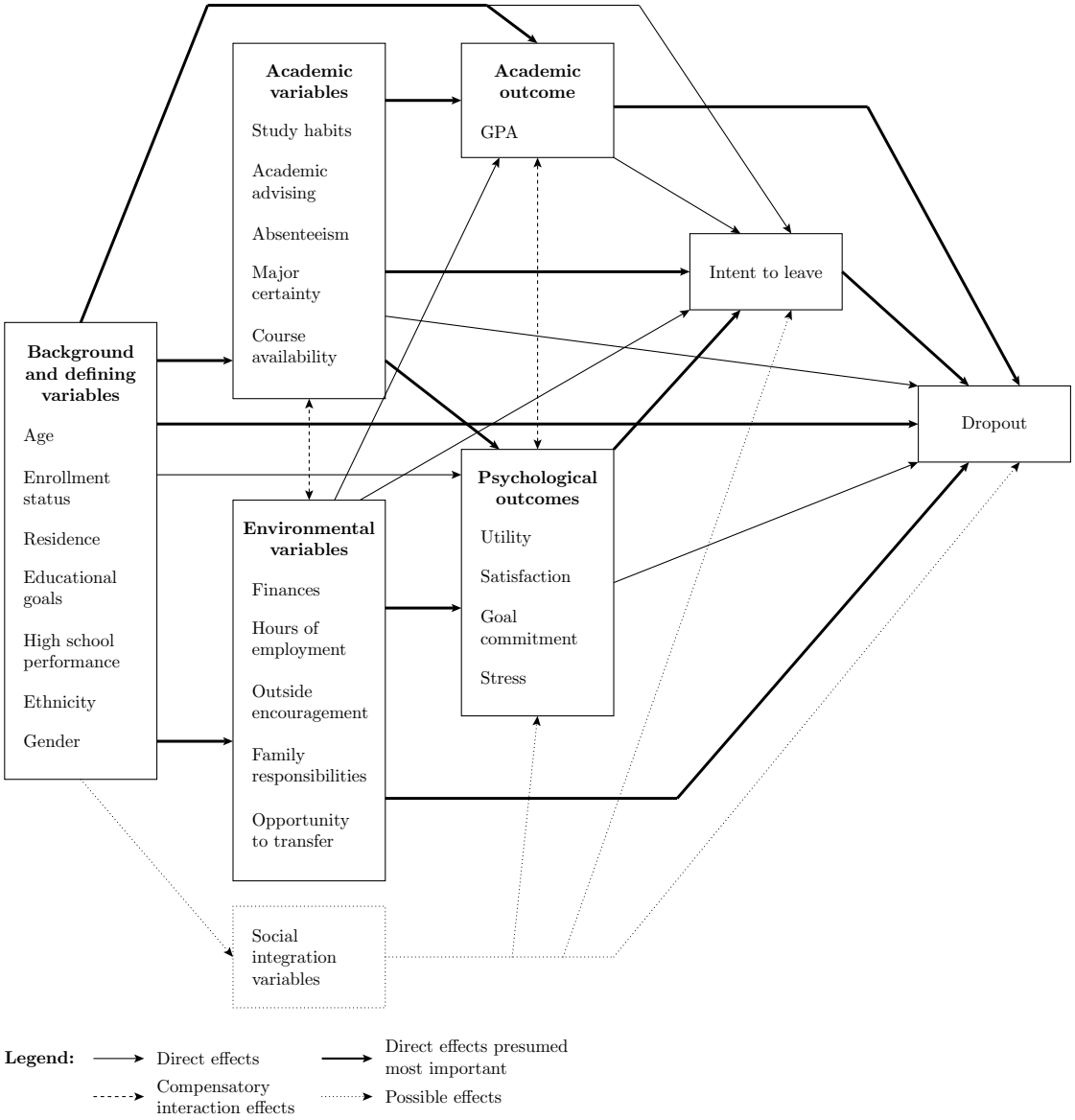

Figure 11: Bean and Metzner's *Conceptual model of student attrition* (redrawn from [5, p. 491])

2.5.3.3 Rovai's *Composite persistence model* The dropout models presented above are targeted at traditional classroom instruction and as such do not take into account the features of distance education[9]. In contrast to them Alfred Rovai's *Composite persistence model* [119] combines and expands the previous two models by concentrating on e-learning dropout. The model has been used to various degrees in previous research encountered in the literature review [108, 109, 103, 107].

[9]Bean and Metzner's model takes into account commuter students as mentioned earlier, but is not a distance education model.

Rovai's model brings three important additions to the models above: Firstly it adds a category called *student skills*, which distance learners require to successfully operate in an online distance learning environment, such as computer literacy, information literacy, time management, reading and writing skills, and online interaction skills. It is argued that if learners lack these skills without overcoming the lack of them, it can lead to attrition.

Secondly the model includes the course *pedagogy*, i.e. learning and teaching styles – although as a special note it does not include course didactics [103, p. 665].

Thirdly the model distinguishes factors that are present *prior* and *after* admission. Some of the factors present before admission can be affected by coaching the student before the course, if feasible given the possible time limitations. This is contrasted by the factors present after admission, which can to an extent be affected by the trainer. These have also been labeled as *characteristics* and *circumstances* [60] (originally [61]). The former are slow to change and in the original text include such variables as educational background, motivation and personality. The latter are likely to change faster, including items as health, financial situation, occupational changes and family relationships.

The model is depicted in Figure 12 on the following page. The model is presented already in the classroom section as it brings to light some new features related to computing education that are discussed in subsection 3.2 on page 45.

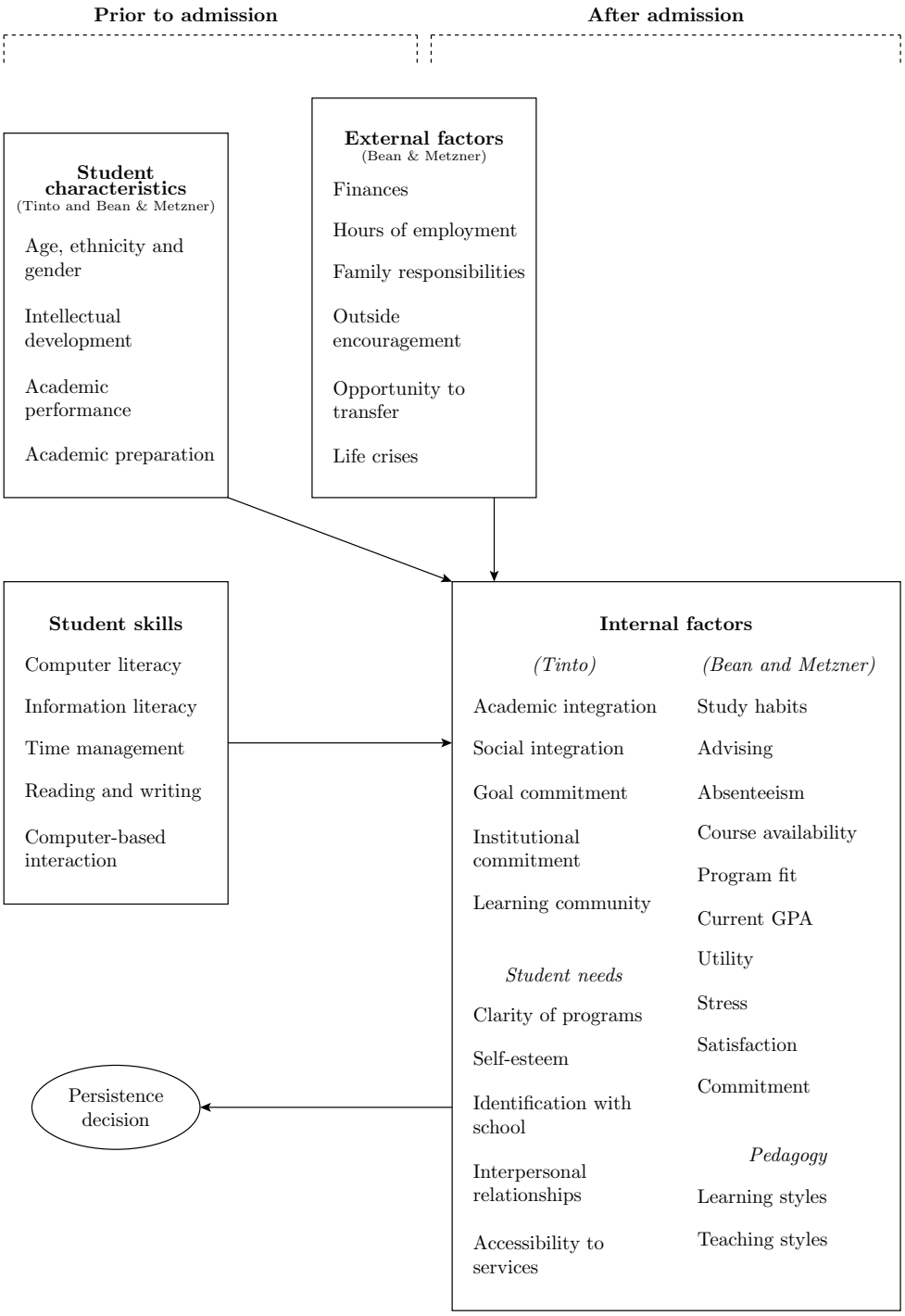

Figure 12: Rovai's *Composite persistence model* (redrawn from [119, p. 9])

2.6 Dropout in e-learning courses

2.6.1 Dropout in e-learning as a phenomenon

The same analysation about the definition of dropout already presented in subsection 2.5.1 on page 24 holds also here. The major difference is the addition of a longitudinal aspect to the phenomenon, as an e-learning version can be used for a longer time than the few days spent in classroom instruction. Furthermore there are some findings that do not have a counterpart in the short classroom-based courses.

Firstly, there is evidence that the *asynchronous* model of distance education sees substantially higher dropout percentages than the *synchronous* model [7, p. 408].

Secondly, the course type of *Online courseware*, *Online distance education*, or *Online collaborative learning* definitely plays a part when dropout is researched. No prior conclusions about the effect of the types should be made however, as there is evidence that a course with no social interaction can be highly successful with professionals [121], or that the social features can be very difficult to organise with professionals [83, p. 113]. In contrast to these some studies find a lack of social interaction to be the most severe barrier to course completion [98, p. 45]. And at least in university settings the presence of an instructor has been deemed important [67].

2.6.2 Reasons for dropout

Dropout in *distance education* has long been a well-studied phenomenon [95, p. 96]. However, models for analysing dropout reasons in distance education are relatively new as it was claimed as lately as 1989 by David Kember that there were no adequate conceptual models of dropout [60, p. 281].

Kember himself proposed a model called *Model of drop-out from distance education* [60] based on Tinto's model but taking into account for example the greater role of background variables as they can be assumed to play a greater role in distance education than in classroom education. Kember's model – even if it is a tested one – is not repeated here because it has been further developed later as can be seen in the next paragraphs.

2.6.2.1 Park's *Theoretical framework for adult dropout in online learning*

Rovai's *Composite persistence model* described in subsection 2.5.3.3 on page 30 has been expanded by Park based on a review of 18 earlier studies of dropout in adult online education, and on Kember's model mentioned in the previous paragraph [108, 109]. Park's model can be seen in Figure 13 on the following page; the essential features are elaborated below.

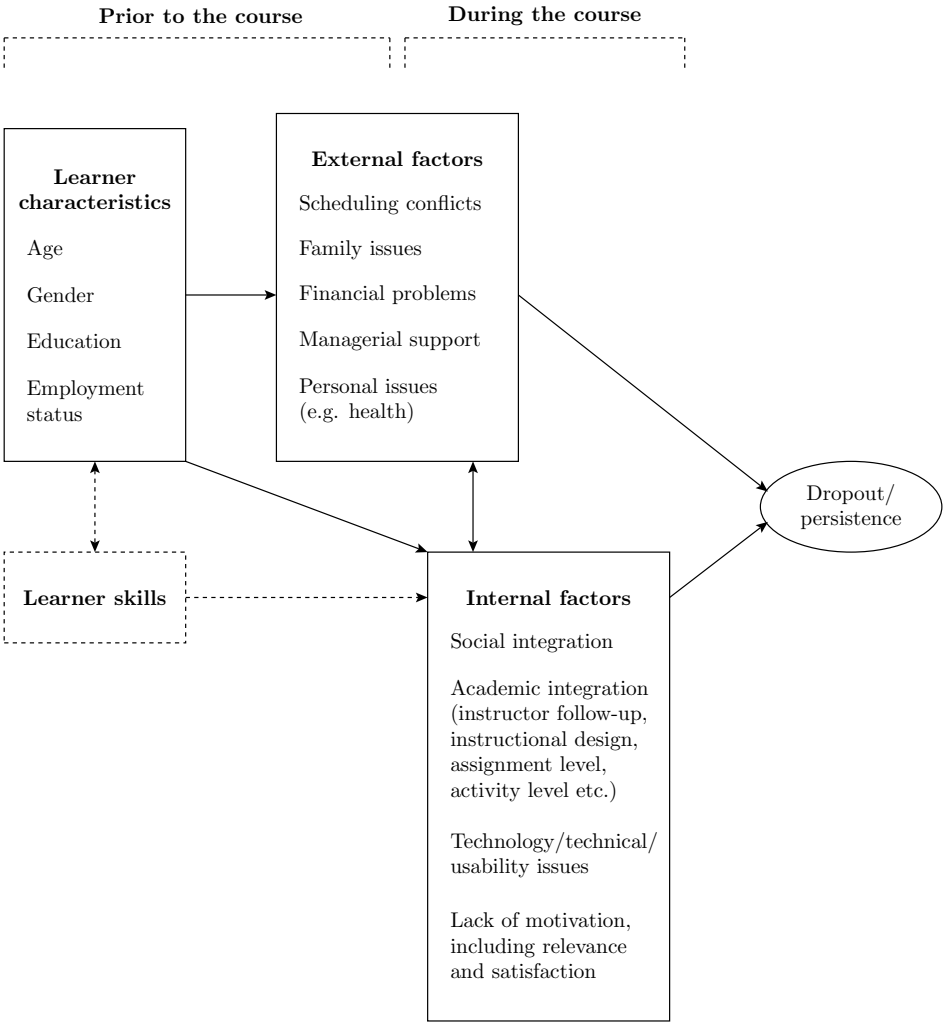

Figure 13: Park's *Theoretical framework for adult dropout in online learning* (borrowed from [108, p. 255]; clarified "Lack of motivation" to include relevance and satisfaction)

Revision of the structure of Rovai's model The external and internal factors are likely to interact with each other, thus the arrow between internal and external factors is shown as a two-way influence. For example, during heavy workload a student is more apt to drop out if the teacher cannot be contacted than when contacting the teacher is easy.

In Rovai's model it appears that only internal factors would have a direct influence on persistence decision. Park reports however that studies show that some external factors can be a major reason for dropout when adult distance education students are concerned. Thus a direct line from external factors to dropout/persistence decision has been added.

The complete model *Learner characteristics* are included in the model, as in all the other models discussed above. Regarding adult online education there is however evidence that the influence of learner characteristics on dropout is a minor or indirect one.

Learner skills are in a dashed box as they have not been verified by previous research due to a lack of such studies. Learner skills are not entirely omitted but are stated to need further investigation.

In the context of adult online education almost all studies have found *external factors* to be significant in relation to dropout. The most frequently cited factor in this group is scheduling conflict.

Concerning *internal factors*, course design including the amount and level of coursework and assignments has seen support in many studies. Other strong factors are motivation, lack of support from tutors or difficulty contacting them, technical problems or dissatisfaction with the online environment, a mismatch between the student needs and the course content, i.e. relevance, and satisfaction[10].

2.7 Why dropout is a problem?

2.7.1 The student

2.7.1.1 Financial penalties In the context of this study the financial penalties for leaving either the classroom or e-learning versions of the courses are possible in the case of unemployment education paid by the government directly or via re-education programmes. While not a major source of turnover for the training provider company, such programmes are not rare either.

2.7.1.2 Knowledge not gained If the content delivered by the course is something that expands the knowledge possessed by the student, dropout is problematic as the information remains not gained. This is highly dependent on the type of the dropout as discussed in subsection 2.5.1 on page 24.

2.7.1.3 Personal aspects Dropout can cause some students to suffer from a sense of personal failure and inadequacy [90, p. 45]. And students who feel that they failed in the education system the first time round can suffer a repeated sense of failure from which they may never recover, thus hindering future participation [76].

In the case of longer further education programmes consisting of multiple short courses, students aged over 30 have less time to start a programme again and their circumstances may in any case rule out the option.

2.7.2 The employer

Essentially dropout is problematic for the employer as they are not getting the knowledge and capability they desire. This can be either prominent in the case of the employer knowing about the dropout, or hidden when the course seems to be completed but no real learning has taken place[11].

[10] Relevance and satisfaction were added to the model as sub-dimensions of motivation in the textual content of [109].

[11] Given the definition in this study given in subsection 4.4.1 on page 50 also this latter situation counts as dropout.

Dropout may also mean that some or all costs of the participation have incurred without the employer getting the full benefits of them. The costs may be direct in the form of course payments, or indirect in the form of lost work hours. The lost work hours may mean time spent during training, or time spent doing work assignments with less capability than would have been obtainable by completing the training.

2.7.3 The course provider

In the case of e-learning high dropout can be critical in collaborative scenarios [103]. If social features have been designed to be a prominent feature of the e-learning platform, and very few students actually use the environment, the course experience may deteriorate considerably[12].

For the course provider every participation has financial consequences [138, p. 153], by for example creating work in the form of registration handling and resource allocation. The resources include classroom spots and trainers in the case of classroom instruction, and computing resources in the case of e-learning. Some of these resources even carry a fixed price, for example the license for an e-learning platform, which in the case of early dropout and related loss of profit may mean that the course provider is getting less money in than it is paying for the platform. This of course depends on whether the course is paid for upfront or only upon successful completion.

Furthermore, if dropout is prominent it may lead to a loss of company-type customers, both in the case of direct customers and re-education programmes offered via other further education training companies. The cost of this kind of loss is not immediate.

As closing words it is worth pointing out that there exists a substantial amount of competition in the e-learning area targeting computing professionals. To make the situation even more difficult, a MOOC course provider targeting computing professionals, Udacity [144], provides lots of their content free of charge.

[12] This is a problem for the students also.

3 Application of theory

3.1 Comparison of classroom and e-learning instruction

In this section the comparison of the two forms of instruction is related to the short course format in computing education that is the objective of this study. Dissimilar subjects – for example "soft skills", like management education – or dissimilar course formats – for example semester-long formal education classes – typically have a more varied palette of educational activities.

3.1.1 The Conversational framework

It is important to notice that the following paragraphs consider various techniques from the viewpoint of the Conversational framework, which has for example defined "learning through acquisition" in a certain way (see especially Table 4 on page 16). A lecture as an event might well contain a mix of other features also, which would fall into other categories of the framework [104, p. 19][105, p. 250].

3.1.1.1 Learning through acquisition The traditional format of lecturing, "learning through acquisition" [73, pp. 96, 105], is the cornerstone of teaching both in the short course classroom format and in the basic form of e-learning named Online courseware (defined in subsection 2.4.3.2 on page 13).

When the short course classroom education and a basic form of Online courseware are contrasted by using the features presented the Conversational framework, the major difference is the lack of demonstrations of techniques, performed by the teacher, in the latter one. The definition of Online courseware does not prohibit the usage of demonstrations, either as videos or as runnable programming demos made possible especially when teaching a programming language that can be run in the web browser environment. The starting point of this research however is to make do without the demonstrations in the e-learning content, as creating them is a major undertaking for the teacher and as such is not feasible in most cases due to high cost in working hours. Thus the demonstrations or lack of them form a clear difference between the classroom and Online courseware formats.

Another possible difference manifests itself when the iterations of either of the *teacher communication cycle* or the *internal learning cycle* are considered. When the teacher is a live person, she has the means of adjusting the amount of repetition on a given subject, for example when she knows that the subject is of specific importance, or when the students give signs of not understanding something. A further example would be taking personal learning styles into account[13] by including various forms of presentation – although during the short courses noticing such needs, or having the means to adjust to them is difficult to say the least. But in all, the teacher has some means of adjusting both the teacher and internal learning cycles. When the learning happens through static text, all this becomes the responsibility of the student. However a more advanced computer-based system might analyse the behaviour of the learner and

[13] Although there is evidence that taking learning styles into account does not cause the students to work hard [33].

adjust the content in various ways, as noted in [125, p. 508] when comparing classroom and mobile device based instruction.

Finally, noticing and handling possible misconceptions is a noteworthy aspect [42, p. 2]. In classroom-based education this depends on the teacher and her or his capabilities. In an e-learning system for example formative tests can be used to achieve the same.

3.1.1.2 Learning through practice

Completing readymade and well instructed exercises has been a cornerstone of short courses in computing education. Programming as a subject has a privilege that it always forms a type of practice environment that gives feedback to the programmer via the warnings and error messages of the compiling and running environments, and via the operation of the running computer program itself.

As there was a difference between classroom and Online courseware formats in the learning through acquisition aspect, no huge differences arise when learning through practice [73, pp. 96, 162] is contrasted. Rather similar exercises can be used in the e-learning environment as in the classroom one. There are practical questions about how to set up the exercise environment, but recently virtual machines, remote desktop connections, and in the case of the JavaScript language, even whole browser-based programming environments[14] make the construction of such an environment relatively painless for the teacher. A difference worth mentioning can however be found related to problem situations when a student works on the exercises; in a classroom environment the teacher can instantaneously be consulted, but not so in an e-learning setting.

It is worth noting that the similarity in learning through practice is unique to the field of computing education. In a study that analysed ICT resource usage at a university, the examples of non-computer based activities found were markedly different from computer-based ones. Examples of the first kind included the following: laboratory, field trip, simulation, and role play. The latter consisted of drill and practice, tutorial programmes, simulations, and virtual environments [25, p. 5].

3.1.1.3 Peer communication and modelling cycles

Some subjects regarding for example software architecture or agile processes lend themselves naturally to group discussions and exercises, but this rarely is the case in programming language education, which for the most part is rather objectivist in nature. A similar observation was made in a study that analysed a university course using Laurillard's framework [117, p. 405]. As the classroom course schedules are very or even extremely tight, it is often a conscious choice on part of the teacher not to specifically elicit discussion to save time.

Also questions made by other students, which would also fall to the peer communication category are typically few and far between, or missing altogether. Thus the right side of the Conversational framework, namely the influence of the *peers* in both articulation and practice phases, is noticeably absent from the computing education classroom courses at least in the case of the company in this research.

In contrast to this, even if the Online courseware format by definition does not have peers present, the e-learning system itself can act as a peer as noted

[14] For example Cloud9, `https://c9.io/`.

in [126, p. 228] and [89, p. 34]. Quoting from the former:

> The partner may be a teacher, or another learner, or it may be computer interactive technology.

Thus, depending on the implementation, the e-learning system can elicit more cycles from the student than classroom instruction.

3.1.1.4 Summary: Conversational framework in the context of the study The most noticeable differences according to the Conversational framework are in the *iterations* of either of the teacher communication cycle or of the internal learning cycle, or in the *demonstrations* (or lack thereof), or in problematic exercise situations.

So if the material and the exercises are similar, the first major difference is found in the teacher's command of the training situation. He or she can concentrate the focus of the training and thus elicit more iterations related to important or difficult content.

The difference in the existence of demonstrations performed by the teacher form the second major distinction – they are typically heavily utilised when a teacher is involved.

The difference in getting aid in problem situations is a third difference worth a mention.

The peer communication and modelling cycles are mostly missing from both forms of teaching, although there is variation in the classroom courses depending on the amount of questions presented.

3.1.2 Cognitive theory of multimedia learning

While creating the Cognitive theory of multimedia learning [87], it was discovered that no media effects existed in situations where the same instructional methods were used with books and computers [88]. Or quoting from [19], originally [17]:

> From the plethora of media comparison research conducted over the past sixty years, we have learned that it's not the delivery medium, but rather the instructional methods that cause learning

Considering the most basic version of e-learning, Online courseware, the Cognitive theory of multimedia learning points out a major difference between classroom and e-learning instruction: the usage of the auditory channel. In classroom instruction the three presentation modes of speech, text, and images drawn by the teacher are commonly utilised. In an online courseware the first is clearly absent if videos, simulations[15], or audio content is not used.

As creating video content or simulations is very demanding time-wise – and thus very expensive – in this research setting they were omitted. The decision was a conscious one following the real world pattern how e-learning would be utilised in the target company setting regarding programming instruction. This is also supported by a recent study that found evidence that there may not be any benefit from using multiple channels if the tasks are of low complexity

[15] For example algorithm visualisations

[85], meaning that the usefulness of using multiple channels would need to be separately studied in the context of further education in computing.

Related to the Multimedia principle [87, p. 47] presented on page 20, the instructional materials in the classroom and e-learning instruction were made as similar as possible in the later stages of this study, in order not to create any unnecessary differences between the two.

3.1.3 Cognitive load theory

3.1.3.1 Intrinsic load Intrinsic load [94, p. 15][134, p. 40] essentially has three components: prior knowledge of the learner, her intellectual abilities, and the complexity of the presented material. Related to classroom and e-learning versions of a given course there is no difference between the first two aspects – the learner is the same. However a major difference arises when the complexity is contrasted with these two aspects: a living teacher has the possibility of adapting the content and presentation to the capabilities of the learner by breaking the content into smaller parts. In contrast to this, in a basic e-learning environment the adaptation has to be done by the student. The difference does not mean that adaptation done by the student is a worse approach – it may suit some learners even better. An example would be listening to a live presentation aimed at a different skill level, which probably is less efficient than using online content.

Regarding this research, a basic version of e-learning was selected, but the theory – and the research findings presented later – strongly suggest that an adaptive version of e-learning material should be considered as a candidate for future comparative research.

3.1.3.2 Extraneous load The extraneous load [94, p. 11][134, p. 42] caused by a non-perfect instructional presentation, including the environment, can easily create a difference between classroom and e-learning instruction. For example an inappropriate physical classroom setting may hinder instruction, as can an e-learning system that is difficult to use or that contains non-essential elements, for example moving pictures to cheer up the student. Especially considering the e-learning environment, the initial learning of the navigation and logic of the environment always creates unnecessary cognitive load. This does not necessarily mean that the learning results of e-learning are worse than classroom instruction: in a study comparing the two by using Cognitive load theory, the cognitive load was reported to be higher in the e-learning version, but the learning results also were better in it [78, p. 606].

In this study all effort was made to construct the e-learning environment as easy to use and as distraction free as possible to reduce the difference between classroom and e-learning versions. For example decorative elements were left to a minimum, the colours and fonts were chosen to be clearly readable, and navigation was made using traditional separate and bookmarkable HTML pages.

3.1.3.3 Germane load Germane load has been defined as the amount of invested mental effort [94, p. 17][134, p. 43]. It has been a difficult to analyse, as raising it is often tied to reducing either or both of the other kinds of load mentioned above, and thus the source of learning changes is not straightforward to differentiate. However some examples of working strategies have been found. As an example, analysing several worked examples of a subject have been found

to aid in learning [106]. Using imagination about a procedure before attempting to carry out the said procedure has also been noticed to have positive effects on learning [74]. Finding such strategies is unfortunately not straightforward, as for example promoting self-explanation in material has been found to have both beneficial and hindering effects on learning [8]. Similarly in a study analysing normal and flipped classroom instruction using Cognitive load theory, the results of higher germane load varied in learning outcomes [85].

All of these examples could be utilised in either a classroom or an e-learning environment, and as such cannot be counted as a differentiator between the two.

3.1.4 Expertise reversal effect

While this research analyses e-learning targeted to software development professionals, there naturally is great variation in their backgrounds and skill sets. Some of them for example know only COBOL or a variant thereof, so that the syntax of the heavily utilised contemporary C and C++ based languages as for example JavaScript, Java, C#, or PHP are alien to them. Some of the participants may have entered the software development field after formal schooling in it, but some may have entered the industry from other professions, like software testing or user interface design.

As a further differentiator, some participants may be extremely well aware of the structure, protocols, and techniques of web server development, typically also having an excellent command of the HTML and CSS techniques. And some have only used a browser without ever paying attention to what goes on behind the curtains.

When the JavaScript language is taken is an example of course content, typical participant profiles could be as in the box below.

JavaScript language course participant profiles

1. No knowledge of C or C++ based languages, or HTML – everything is new
2. Good command of Java, C#, or PHP
    (a) With or without web server programming knowledge
3. Some basic JavaScript knowledge, but not real knowledge of the prominent real features such as it being a dynamic and a functional programming language; basically always combined with at least basic knowledge of HTML
4. Good JavaScript knowledge, typically always combined with a good knowledge of HTML

A competent teacher can usually adjust teaching so that the background of the students are taken into account. Understandably there is differences in this from teacher to teacher, between various subjects, and even between student groups – in a very homogenous group adjustments are far easier to make than in a heterogenous one.

An e-learning course of the basic Online courseware type, when targeted to a certain audience, has to be written so that the persons with the least amount of

knowledge in the target group can successfully cope with the content. So, when the expertise reversal effect [58] is considered and contrasted with the profile categories 2–4 shown in the box above, it can be seen that there clearly exists a possibility of the effect playing a part.

As in the intrinsic load paragraph above on page 40, adaptive content could be considered an evident correction to the problem caused by expertise reversal effect [57], but it remains an idea for further study.

An interesting detail related to expertise reversal effect is the usage of video content, which has recently become popular in some manifestations of e-learning[16]. Video as a format removes from the expert the capability of quickly browsing a subject. So, whereas a correct and enlightened use of videos is generally of importance [124], this manifestation of expertise reversal effect is worth being aware of, and in its way supports the basic version of online content chosen for this study.

3.1.5 Summary: Cognitive theory of multimedia learning, Cognitive load theory, and Expertise reversal effect in the context of the study

Considering a basic version of e-learning, Online courseware, the *Cognitive theory of multimedia learning* shows a major difference between classroom and e-learning instruction in the usage of the auditory channel. In a classroom the three presentation modes of speech, text, and images are commonly utilised. In an online courseware the first is absent if animations, videos, or audio content are not used.

The *Cognitive load theory* presents three different loads in a learning situation. Regarding the first one, *Intrinsic load*, a living teacher has the possibility of adapting the content and presentation to the capabilities of the learner, whereas in a basic e-learning environment the adaptation is done by the student. The second one, *Extraneous load*, can often be found to be unnecessarily great in an e-learning environment, as the initial learning of the navigation and logic of the environment always creates some cognitive load. The third one, *Germane load*, depends on the exact strategies used to increase it. Likely the same strategies can be utilised in both classroom and e-learning environments.

The *Expertise reversal effect* clearly distinguishes classroom and e-learning content, as a teacher can adjust the teaching at least to a certain degree to suit the level of expertise of an audience. In an e-learning environment consisting of static content the adjustment is again done by the student.

3.1.6 Motivational framework for culturally responsive teaching

In a classroom situation all the features of the framework are highly dependent on the actions of the teacher, and as such are only analysed as confronted in this study's classroom settings.

3.1.6.1 Establishing inclusion In the basic format of e-learning chosen for the research, Online courseware, lacking any social aspects, the possibility

[16] Khan Academy, `https://www.khanacademy.org/`, being probably the most well-known one.

of inclusion [147, pp. 126–127] is glaringly missing. As there is no teacher or peer presence, there can be no group inclusion.

None of the teachers on the classroom courses analysed accentuates establishing inclusion in their teaching – for example introductions are made but no group exercises or any other inclusion promoting activities are utilised. During the breaks the teachers also had a break of their own, or were available in the classroom for questions, but did not typically participate in coffee or lunch break discussions.

In all, in the context of this study there exists the difference of being in a group of actual persons or not, but the difference is basically as small as it can possibly be.

3.1.6.2 Developing attitude *Emphasising* the relevance of the subject [147, p. 172] was a feature in classroom instruction that had noticeable variability between teachers – some did not specifically mention the importance of the subject even at the start of the course, some did regularly remind the students about it.

The e-learning version used in this study, concentrating on the very basics of the JavaScript language, followed the first route in order to be as basic as possible, and giving room to possible followup research that can pay attention to the specific motivational features. Small features that emphasise the relevance could however be added also to an Online courseware type course: in a study that analysed enhancing an online course following the Motivational framework, a simple idea of letting the tutors write about the relevance of the course for them in the course content was utilised [29, p. 33].

Relevance can also be *enhanced* by tailoring the course content to the needs of the participants, as suggested in a study reviewing instructional development programs utilising factors that according to Wlodkowski motivate adult learning [34]. In a classroom setting the possibilities for this depends on the capabilities of the teacher, on the subject, on the material available, and on the composition of the student group. In an online setting – considering Online courseware – the adaptation remains at the learner. This is not to say that attention could not be paid to it, as for example easy navigation aids in such self-adaptation.

3.1.6.3 Enhancing meaning Creating challenging and engaging learning experiences [147, p. 226] is probably the most difficult factor of the motivational framework to actualise in a short course format, be it in the physical classroom setting or delivered as e-learning. The basic idea of the short courses spanning only a few days is to be as effective as possible in covering large sets of information, and thus the focus of the teaching must be in understanding the facts instead of remembering them for a long time. This said, the importance of practice has been underlined in previous studies [34] and it warrants special attention.

Given the time limits mentioned above, the exercises must also be limited in time, and as such cannot be very demanding – if the exercises concentrate on active programming performance, the time usage difference between students easily explodes. Thus the gold standard of exercises has mostly become a copy–paste one to keep the time usage at bay and to keep the student differences manageable. There is naturally some difference between teachers – some prefer

a format consisting of very small, "hello world" type exercises, and some create larger programs that are close to real-world usage, and during the exercises then some incomplete portions of the programs are filled in.

It is worth noting that considerable variation even in the "hello world" type exercises is possible: even a small exercise can mimic a real world use case – or not. For example a typical function of a web user interface is a drop-down menu, which when selected changes the values in another drop-down menu. This can be either written to contain actual values, e.g. a list of provinces of a country, the selection of which alters another menu to contain the cities of the chosen province. Or the exercise might contain only some random strings in both menus. The programming exercise would be similar in both cases, but the first one can be argued to be more interesting and understandable, and it is easier for the student to think of the concrete utility of the feature that she has experienced.

3.1.6.4 Engendering competence Creating an understanding that learners are effective in learning [147, p. 310] is a feature noted in a study comparing various theories of motivation to have two possible sources: internal, found within the student's sense of achievement, or external, such as various tests [70, p. 49]. It is worth noting that internal standards may differ from those established by others, so learning activities are best designed to recognise and reward both.

Regarding the sense of achievement, by controlling the speed of the course the teacher has the possibility of either ensuring the comfort of all the learners by giving enough time for all to understand the content and for all to complete the exercises. Or the teacher may want to ensure that the fastest and most knowledgeable students are served best and their speed of progress is followed.

This is a major differentiator between the classroom and e-learning versions analysed in this study. As the e-learning course only had a deadline of the material being in use until the classroom course for which it was the prerequisite for, the students could freely choose their pace of progress. In the classroom all the power to decide upon the speed was on the teacher. Moreover, there was difference between teachers as mentioned in the previous paragraph – some tried to ensure that all students can follow the content and manage at least the basic exercises, some followed the speed of the fastest students, or of the middle performer group.

On the other hand, if in an e-learning situation of the Online courseware type something is not understood, or an unsolvable problem arises in an exercise, the student is left without aid, and a feeling of competence is lost. Or if help is asked for by utilising internet resources, receiving an answer can take a long time. In a classroom situation clarifications can be asked or aid can be requested with an immediate response.

Regarding external sources of engendering competence, they may include for example oral, written, or performance tests [70, p. 49]. In the case of this study such were not desired in classroom instruction as discussed in subsection 1.2.7 on page 3, and as such were omitted from the online version to keep them as close to each other than possible. Implementing such tests in the e-learning version would be relatively easy though.

3.1.6.5 Summary: Motivational framework in the context of the study The most salient differentiator between e-learning and classroom instruction in the context of short commercial computing education courses is the aspect of *engendering competence*, meaning that the learners feel that they are effective in learning. In a classroom environment the teacher controls the speed of the course, which can cause a feeling of incompetence, but on the other hand questions can be asked or aid can be requested. In an e-learning environment the situation turns around, as the speed can be controlled by the learner, but no aid is readily available.

The other features of the framework, that is *establishing inclusion*, *developing attitude*, and *enhancing meaning*, are mostly dependent on a given teacher or material. In the context of this study the differences are relatively minimal. Perhaps the greatest difference arises in the last one – especially concerning exercises – as some classroom courses only have small, "hello world" type exercises. Such exercises show the features of a language or framework, but fail to enhance meaning.

3.2 Dropout in classroom instruction

3.2.1 Study interests

In the case of this study the interest is twofold: how much dropout does happen, and which are the features that act as cause agents for dropout. Considering the latter question it is more interesting to analyse facets that can be affected upon, such as student skills, than unchangeable features like age, ethnicity, or gender.

3.2.2 Rovai's Composite persistence model

Rovai's *Composite persistence model* [119] is taken as the basis for analysis as it has expanded the other often utilised models depicted in subsection 2.5.3 on page 26 especially by introducing the separation into features mostly affecting the time before the course, and features in effect during the course. The model has also earlier been used in classroom dropout research in adult education [153].

3.2.2.1 Student characteristics *Academic preparation* as a term means the wide spectrum of skills needed to cope at university level. As such it is not relevant in this study.

Academic performance prior to the course may affect the conscious or subconscious feelings of the student towards classroom education [147, p. 176][66, p. 64]. This is unfortunately difficult to measure, and mostly falls under the teacher's empathy to cover. Moreover there is no anecdotal evidence that prior schooling would have affected the classroom situations in computing education.

The effect of students' background characteristics like age or gender has not gathered support related to persistence in online adult education [77, p. 330]. Furthermore it is a factor that cannot be affected in classroom courses, as for example gathering age or gender information would not be feasible in corporate training.

3.2.2.2 Student skills *Student skills* play a lesser role in classroom than in online education as the teacher is readily present and able to give aid in an event of need. There are naturally differences in the computer use capabilities, but in this study all the course participants are computing professionals and they should not have major hurdles in navigating around in a contemporary computer operating system. Moreover, should basic computer usage affect dropout in a given case, it is unlikely that the situation could be remedied prior to the course.

3.2.2.3 External factors Most of the external factors do not play a great part during a short course of only some days, which is paid for by the employer. Notable exceptions are

- *life crises*, which can cause the student to be distracted, or tired to various degrees, or may force a complete dropout off the course; and
- *outside encouragement* from the employer or colleagues.

These features are difficult to analyse, and neither can be affected upon during the classroom instruction by the trainer or the training organisation.

3.2.2.4 Internal factors The *integration* features are basically absent in most of the computing education courses. The objectivist nature of many of the subjects does not lend itself to group work. In many cases there is little need even to foster discussion about a subject, for example when learning new libraries to a familiar language that forms a relatively large portion of commercial instruction. Of course when learning completely new paradigms such as object-oriented or functional programming at least discussion is desirable. In the case of this study both the Finnish culture and the personal features of many programmers play a part in attenuating the social aspects of a course – many of the participants have attended school when discussion was not a part of elementary education, and an introverted view of live seems to be a feature common amongst computer professionals. Moreover a study utilising Rovai's model in online further education dropout analysis found no support for the integration aspects as dropout sources [114, p. 10].

Program fit includes the previous software development knowledge of a student in the context of this study. Problems with program fit have been found to be a source of dropout in a prior study based on Rovai's model [153, p. 152].

Program fit can be further divided into two categories:

1. Prerequisite knowledge of a subject. For example attending a HTML5 course requires at least some understanding of the JavaScript programming language.
2. Prior knowledge of a subject. It is commonplace, and in many cases beneficial, that the student already is familiar with at least some subjects of a course. Sometimes the student may even be very familiar with all the subjects and only seeks validation for her prior knowledge, or wants to gain insight about best practices in the field.

It is worth noting that in the case of classroom instruction the teacher may have the opportunity to change the subjects to alleviate possible problems. This depends greatly on if the course is company-specific – where such a decision can

be made with either the person who has ordered the course, or sometimes with the participants themselves – or if the course is public and the public syllabus has to be followed.

Also if a student chooses a wrong course, for example a course teaching the libraries of the Java language instead of a course teaching the Java language basics, there is a clear problem with program fit. Apart from interviews this can be analysed by noting the prerequisite and prior knowledge of a student.

Utility, that is how usable the knowledge delivered by a course is unlikely to affect someone that is physically participating on a course – given the notable price of the courses one is unlikely to attend a course with no or little use for the student or for the employer. This may affect *commitment* though – this can be analysed by finding out about the voluntariness of participation. A study analysing persistence in online adult education using Rovai's framework found strongest support for such factors [77, pp. 334–335], also noticed in [114, p. 11].

Pedagogy, including the learning and teaching styles, briefly discussed on page 37, are unlikely to be so strongly contrasted as to cause dropout. It is an interesting aspect but difficult to operationalise and thus in this study will be explored in the student interviews.

3.3 Dropout in e-learning: Park's Theoretical framework for adult dropout in online learning

3.3.1 Learner characteristics

In Park's model [108, 109] the *education* aspect covers the academic preparation and academic performance facets.

3.3.1.1 Student skills Again there should be no great problems in the context of this study as the students are computing professionals. There are slight changes compared to classroom instruction though: teacher help is not readily available, and the students have to install specific software on their computers that would be installed in the classroom computers already in advance by the teacher.

3.3.1.2 External factors As the e-learning course is longer and during this study basically voluntary, external factors are likely to have a sizeable role in e-learning dropout. For example *support from the employer* has been found to be a relevant factor in aiding persistence [56, p. 720]. These aspects cannot be combated by the e-learning course provider however, and thus are no further analysed here.

3.3.1.3 Internal factors The *social integration* features were already discussed in subsection 2.6.1 on page 33 to vary greatly depending on the e-learning course type (Online courseware, Online distance education, or Online collaborative learning).

The *academic integration* has been expanded in Park's model to cover program fit, utility, and pedagogy of Rovai's model. The program fit consisting of prerequisite and prior knowledge is essentially the same as in classroom instruction. This time there is no possibility for adapting the content to each learner at least in a basic version of e-learning, however.

Furthermore the program fit and utility can be assumed to have a great role in e-learning dropout. It is difficult to generate content that would be a good fit for a sizeable portion of the students. A course is far too likely to be either too difficult, or in the case of a course covering the basics of a programming language, to be far too easy, especially in the beginning. As far as utility is concerned, students can be posited to be inclined to dropout a course if the utility is not seen as prominent. This is in agreement with the findings of a study comparing various dropout models including Park's model [45, p. 32], as well as a study that used Park's model to analyse dropout at an online college [47, p. 54].

Similar to the classroom instruction analysis above, pedagogy is not seen as a likely source of dropout.

Regarding academic performance there still exist a possibility of either positive or negative feelings towards e-learning gathered from prior experiences, or even from experiences of studying from any written source.

Technology/technical/usability issues are more likely to play a noticeable part in e-learning than in classroom instruction regarding dropout [129]. Even if the students themselves are very capable in using a computer, broken links or other bugs in an e-learning environment affect them as anyone else.

Lack of motivation is a very possible source for dropout, and has also been a subject of a number of studies in e-learning dropout [64, 120, 16, 45, 47]. It is not easy to combat, but an immensely interesting question – if motivation can be affected to a notable degree by altering the e-learning course delivery in some way, the rewards can be significant.

4 Research material and methods

4.1 The research question

The main research question concerns **how much dropout does happen related to short e-learning courses in the field of professional software development, and what are the main reasons**.

The main question has been split into two subquestions:

RQ 1: What is the dropout in classroom-based courses? What are the main reasons for dropout?

RQ 2: What is the dropout in e-learning courses? What are the main reasons for dropout?

4.2 Research approach

4.2.1 Levels of training evaluation

Kirkpatrick's four levels of training evaluation [65] (further described in [27]) break down the effectiveness of learning. The levels are:

1. reactions, which "involve attitudes toward, and satisfaction with, e-learning or preferences for e-learning compared to other modes of instruction (generally, classroom-based training)" [27, p. 927];
2. learning;
3. behaviour; and
4. organisational results.

Unfortunately as is commonly the case [27, p. 927], only the first level could be analysed also in this study as no course time could be spared for analysing the learning results. The situation has been further clarified in subsection 4.4.1 on the following page. Also the company whose courses and course participants were analysed did not see value in rigorous research concerning the levels of effectiveness.

4.2.2 Distance education study approaches

Distance education research concerning dropout research can be typified to include three broad categories [95, pp. 98–99]. One approach *classifies students* according to their characteristics and tries to identify the students most likely to drop out. Another way is to analyse the *courses* and try to find features associated with high or low dropout rates. And the third way is to find the *explanation from the students* themselves by asking about their reasons to withdraw or persist.

In this research the first and third aspects were analysed. The second one was not feasible as there existed only one e-learning course, but the view remains important when future research is considered.

4.3 Mixed methods

The approach chosen in the major parts of the study use *mixed methods*, which involve combining or integrating qualitative and quantitative research or data in one study [23, p. 14].

The reason for choosing such an approach is that one data source can be used to check the accuracy of the other data source. As an example in this study, in the case of the classroom-based courses qualitative interviews can help to corroborate the findings of the quantitative research that was made in the classroom. Or mixed methods can help explain the other data source, and even explore different types of questions than the other. In the context of this study this is apparent in the e-learning setting, where reasons for the dropout percentage – which has been found out quantitatively – can be found via qualitative interviews, and after that a quantitative survey can give weight to the answers given by the interviewees [23, p. 15].

More specifically the approach chosen is *sequential mixed designs*, defined in [21, p. 25] as:

> "in which one or other of quantitative or qualitative approaches run one after the other, as the research requires, and in which one strand of the research or research approach determines the subsequent strand or approach an in which the major findings from all strands are subsequently synthesised"

4.4 Part I: Dropout in classroom-based courses

4.4.1 Dropout definition in the context of the study

Initially it was attempted to find out what the dropout rate is in short *classroom-based* courses. As quitting[17] the courses has been virtually non-existent, success during the course – measured via exercise completion rate – was used as a factor representing dropout.

As mentioned earlier in section 2.5.1 on page 24, given the short duration of the courses and high price for the participants' employers, no alterations taking a noticeable amount of course time could be used. For a participant clearly dropping out of a course could also be very stigmatising and thus the fact should not in any way be highlighted. For these reasons for example test measuring learning could not be added to the end of a course. Also a questionnaire about student satisfaction was already utilised at the end of a course, and it was not possible to expand it.

On the other hand, measuring learning would not be entirely relevant as short courses necessarily cannot aim to thorough memorising of content, or even understanding every concept – a major giveaway of short courses is to see "what exists" in a given subject in programming, to see best practices, or to see examples of complete software architectures. This corresponds mostly to the *comprehension* level in Bloom's taxonomy [9, p. 204], or to the *understand* level of a newer *Taxonomy for learning, teaching, and assessing*, which is shown in Figure 14 on the following page [3]. As a note regarding the latter one, exercises have not been placed in the *apply* category, as they for a large part consist of following precise instructions.

[17] I.e. leaving the class altogether

The knowledge dimension	**The cognitive process dimension**					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual knowledge		*lesson objective*				
Conceptual knowledge		*lesson objective*				
Procedural knowledge		*exercise objective*				
Metacognitive knowledge						

Figure 14: "A taxonomy for learning, teaching, and assessing" in the case of a short course (redrawn from [3], with objectives of the short courses in this study filled in)

So, taking into account the limitations of what could be done in the classroom, the following initial definition was used[18]:

> If the student has passed at least 25% of the exercises of the course, the participation counts as a success

The information was obtained mostly via self-report in which the students used a web-based interface to report on their success or failure in classroom exercises. Trainer comments were also used if they were available – in some (rare) cases the trainer could tell that someone had major trouble in coping with the course content but they had not used the reporting application.

4.4.2 Research setup

The approach is depicted in Figure 15 on the following page (notations following [24]) and elaborated below it.

[18]The definition is further discussed and elaborated in the results section 5.1 on page 74.

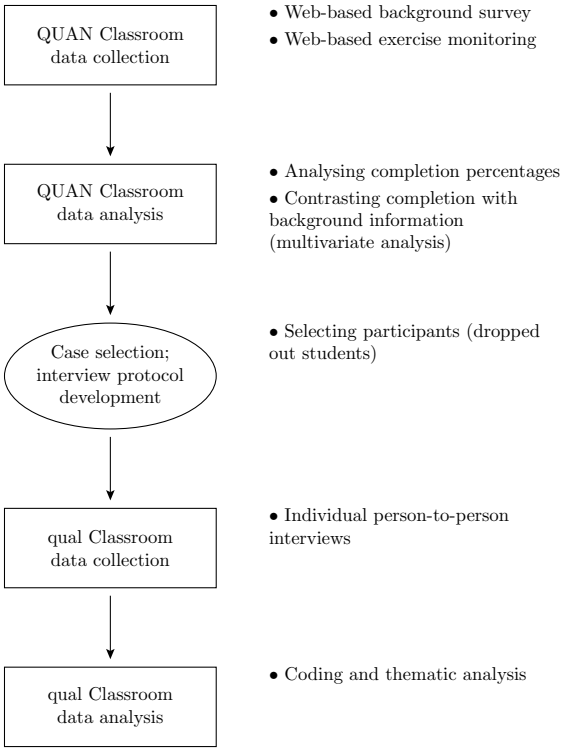

Figure 15: Diagram for Part I

4.4.2.1 Quantitative phase: Classroom recording This phase analysed how many exercises were completed independently by following the instructions, or left unfinished, or completed by utilising the example solutions that were typically provided by the teacher. Completing an exercise had a straightforward definition as the exercises of all the teachers followed a step-by-step format, and always resulted in some runnable code.

These factors were recorded via a web-based feedback application during the course; the application user interface and the precise questions asked are treated in subsection 4.4.3 on the next page.

The following major themes about participant background were asked in a questionnaire at the beginning of the course:

- Prior knowledge
- Voluntariness of the participation
- Job function and other verbal background information

These were checked to correspond to the dropout models presented in section 2.5.3 on page 26. Emphasis was given to factors that can be acted on, for example prior knowledge can be accentuated in the course sign-on process of the company if it is found to be a significant factor of dropout, or the customer companies could be notified about possible harmfulness of involuntary participation. As a special mention the aspects of pedagogy brought into light in the theory of subsection 2.5.3.3 on page 30 – while being factors that could

be acted upon – were not queried about in the quantitative phase as they were asked about in the qualitative phase.

Success during the course, recorded via the web interface, has two major themes:

- Quantitative: How many exercises were completed and how far has the participant progressed in single exercises
- Qualitative: Participant comments about any given exercise, especially what was learned and what was difficult

4.4.2.2 Qualitative phase: Interviews In this phase the concept of dropout in classroom-based instruction was elaborated. A selection of students that did complete none or only very little of the exercises were interviewed, and grounded theory method (GTM; named as suggested in [145, p. 2]) was used to find more about:

- Whether the phenomenon was felt as a dropout by the students themselves (for example a very knowledgeable participant might skip exercises if they are too easy for her), inspired by the discussion of the definition of dropout in subsection 2.5.1 on page 24
- To generally explore the results in more depth [52]

4.4.3 Data collection

A web application was constructed for the students to report their progress while doing the exercises. The application has two views, one for background questions and the actual reporting interface. These are elaborated below.

4.4.3.1 Background questions The background questions were divided into questions measuring course related factual knowledge and questions about other background information. The application student interface relating to these can be seen in Appendix B, in Figure 45 and in Figure 46, starting on page 143. How the teacher administered the course, and how the teacher could monitor the progress of the students in the exercises are shown in Appendix C on page 148.

Factual knowledge was measured on a scale from 0 to 5:

0. Does not know the concept
1. The concept is familiar, but the student does not have hands-on experience
2. Experience is through a book / a course, or the student has used it long ago (how long ago was additionally asked)
3. Has used, but usage often requires help or additional material
4. Has used a lot, but usage occasionally requires help or additional material
5. The subject is very familiar, usage almost never requires help or additional material

The pieces of knowledge were marked as *essential*, *helpful*, or *subject knowledge*. This was not visible to the student, but to help the researcher to assess prior and prerequisite knowledge. Some questions did not fall into any category, but were meant only to help the teacher in her lecturing. An example about this grading is given in Table 6 for a course called "HTML5 and CSS3 for software developers (open source)".

Table 6: Prerequisite knowledge grading

Subject	**Essential**	**Helpful**	**Subject knowledge**
HTML 4		×	
CSS 1/2		×	
JavaScript's basic syntax and libraries	×		
jQuery		×	
HTML5's elements			×
CSS3			×
HTML5's JavaScript APIs			×

Other background information was most importantly used to find out about voluntariness concerning the decision to participate on the course. The selectable options were:

1. employer's/superior's order, the student did not personally affect the matter
2. employer's/superior's order, after student's own willingness had been inquired about
3. student's own activity and employer's/superior's stake had about equal effect on the decision to participate
4. student herself was the active applicant and employer/superior agreed to the participation decision after having been asked
5. participation was completely based on student's initiative (e.g. on own time)

Additionally the following textual information was asked about:

- Short description of work tasks
- Position in organisation
- Reason for participation
- Own goals regarding participation on the course
- Usage at work of the knowledge gained on the course (if permitted to tell about)
- Any wishes regarding the course
- Any other comments

Notes on background information As mentioned, *prerequisite knowledge areas* of a course were marked as "essential", "very helpful" or just "for additional knowledge" in the reporting application database. The information was found in the public course descriptions or given by the teacher.

The prior knowledge values were given by students in the background questions, and those numbers were combined by the researcher to a single figure representing prerequisite knowledge. The scale was deliberately made different from the students' self-assessments, as for example for a given course a level of 2 could mean an excellent relevant prerequisite knowledge.

Prior knowledge differs from prerequisite knowledge in that many subjects require some prerequisite skills (for example Java or C# language), but no knowledge about the subject itself (for example Java EE or SharePoint programming). Prior knowledge about the subject is classified as ranked by the student on the scale of 1–5.

4.4.3.2 Classroom exercise reporting

The user interface of the exercise reporting application is shown in Figure 16 on the next page.

Unfortunately quite many students skipped the exercise reporting at some point especially with other trainers than the researcher. Thus the trainers were additionally verbally asked if any of their students could be classified as dropouts due to difficulties in the exercises.

4.4.4 Classroom interviews

4.4.4.1 General

In both qualitative phases of research (i.e. drop-out in classroom-based and e-learning instruction) person-to-person interviews were used. The type of the interviews was semistructured [91, p. 89]. Interviews were chosen as the data collection technique as the questions about not coping with the course contents can be stigmatising for the participants. It was assumed that during an interview it is possible to both create a trusting atmosphere and to stress about the steps taken to ensure anonymity in the study. Moreover with interviews there was better control the variability in the choice of the participants – the usually lower response rate of online surveys[19] [54, p. 197] may cause unwanted bias.

Initially the amount of interviewees in either part of the study was be defined by using the concept of saturation of GTM [41, p. 61]. In the case of the classroom participants this was borderline – minor new aspects were obtained even from the last interview, but unfortunately there were no more available dropout cases at the end of the research. In the case of e-learning all the dropouts were attempted to be contacted and interviewed, as new concepts and views continued to arise.

4.4.4.2 Participant selection

Finding interviewees was a difficult task, as:

- due to a huge bias probability the students of the researcher could not be interviewed;
- due to the global financial problems there were less trainers and less courses than some years earlier;

[19] In fact, in "Research Design" by Creswell [23], surveys are only listed as a quantitative method of data collection.

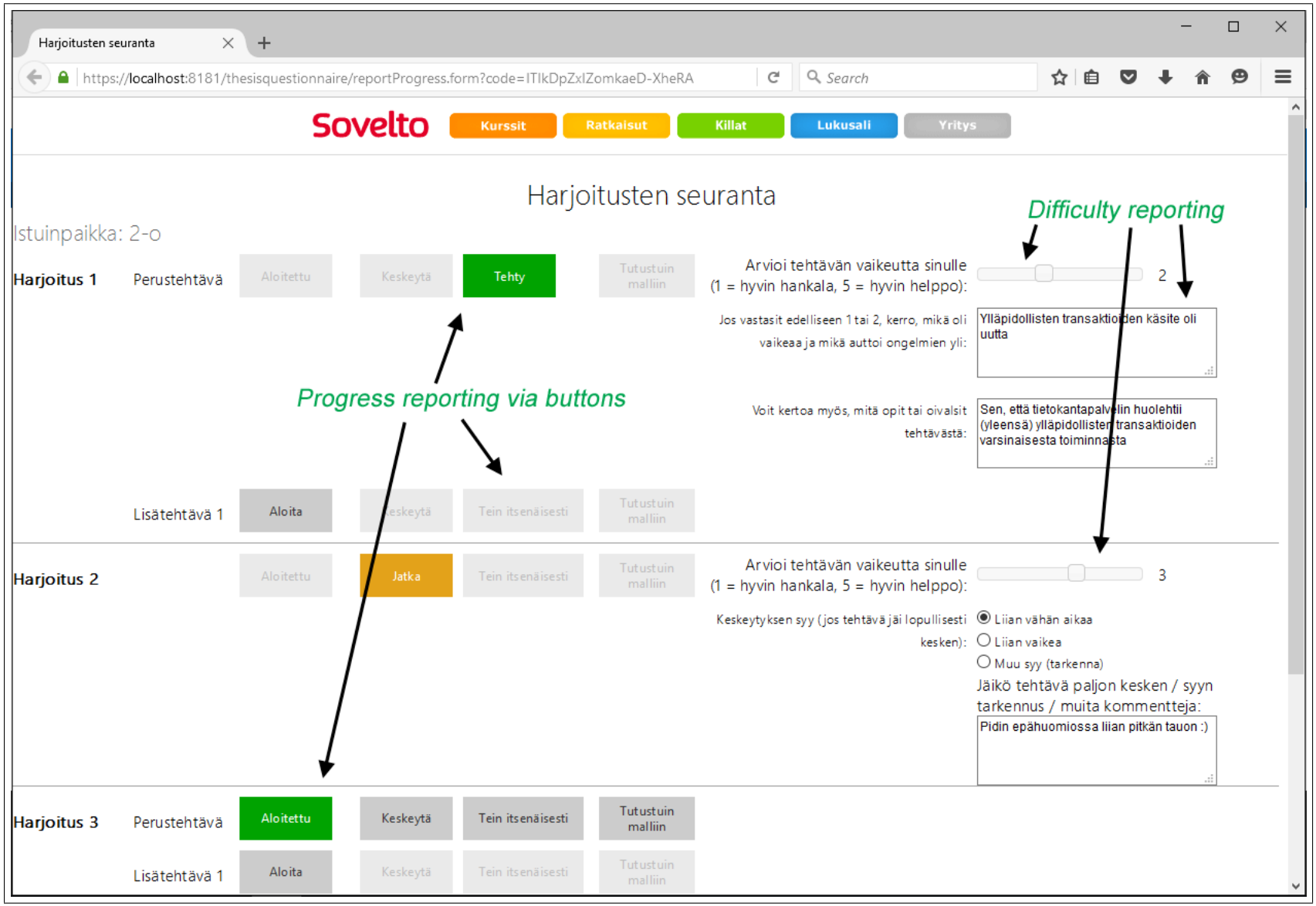

Figure 16: Classroom reporting application: Exercise reporting

- most students had no noticeable problems with the exercises; and
- some courses (for example a course called "AngularJS"; described in Appendix E on page 154) did not have real exercises, only some demonstrations to try on.

Fortunately every possible student did agree to be interviewed.

4.4.4.3 Interview questions The interview questions were formed to elicit as open answers as possible – while paying attention to possible problems in the course experience – and the questions were checked by a knowledgeable peer. Caution was also paid to not steer the interviewee to any direction by the questions. The question sheet was not given to the interviewee in order for her to pay more attention to the actual conversation. All the interviews were recorded and later transcribed.

The question sheet is on the next page[20] [21].

[20] Translated from Finnish by retaining as much as the original wording as possible, causing some unavoidable clumsiness in the sentences.

[21] There were slight changes during the interviews to find out more from the subjects. Given the exploratory aim it is unlikely that the results were compromised in any way. The exact wordings in Finnish can be found as a ZIP file containing four PDFs at `http://bit.ly/1TZRo9z`.

Background The interview concerns a licentiate's thesis, where I compare classroom and e-learning teaching in the training of software developers. Such research has been globally performed very little, as the most research of teaching and learning is focussed on schools and universities.
This part of the research is performed as an interview instead of for example a readymade questionnaire – the meaning is to find out more about the strengths and weaknesses of classroom teaching.
About my own background: I have been training software developers mostly concerning Java server programming for about 18 years.

The questions

1. Why did you participate on the course?
2. What kind of shortcomings did you evaluate to have in your know-how; what did you want to reinforce?
3. How would you evaluate your own prerequisite knowledge in relation to this course?
4. Were you able to estimate the prerequisites in advance well enough or did there surface any surprises that made completing the course more difficult?
5. About the course content: Did some of the subjects feel especially useful?
6. And was some item worthless or was too much time devoted to it? Why?
7. And what aspect of the course did feel difficult?
8. Were the difficulties related to new concepts, which were hard to understand, or to solving the exercises (e.g. problem solving, programming, testing, ...)?
9. Did the exercises support learning?
   (a) If not, why?
10. Was the difficulty level of the exercises on the correct level concerning the subjects being taught?
    (a) That is, if you understood the subject, were you able to complete the exercises
    (b) Or on the other hand, were the exercises too easy
11. What could have been conducted in another manner to make learning easier?
12. How do you feel the time should be divided on a course like this for example between the following aspects:
    (a) teaching new content (lecture style)
    (b) instructed exercises in the classroom
13. And would you be interested in the following?
    (a) exercises prior to the course, made on own time
    (b) exercises after the course, made on own time
14. What kind of form of teaching and working would best support your learning?
15. Would you please describe your general feelings about the course?
16. As an extra question: Have you yourself done any e-learning courses on any subjects related to software development?
17. Any feedback about the conducting of this interview?

4.4.4.4 Interview analysis The study uses the Glaserian version of GTM, as suggested by Urquhart [145]. She argues that the version "offers more flexibility and is closer to the original formulation of grounded theory as put forward in the 1967 book" [145, p. 21]. Also there is scant research on the course types that are the foci of the study, and thus there is a need for developing new theory.

The analysis phase consists of the following stages [145, pp. 9–10]:

1. *Open coding*: Going through the data, line by line or paragraph by paragraph, attaching codes to the data and very much staying open, seeing what the data might be telling
2. *Selective coding*: The open codes are grouped into larger categories, on the basis of the key categories that are shaping the theory
3. *Theoretical coding*: Those categories are related to each other and the relationship between them considered. This is the act of building theory – finding constructs, connecting them, and considering the nature of that relationship.

4.5 Part II: Dropout in e-learning courses

4.5.1 Research approach

The approach chosen also in this part of the study used *sequential mixed designs*, defined in subsection 4.3 on page 50. The organisation was as follows:

- In the first phase students got an e-learning system to use. The system analysed the students' behaviour and dropped out students were found.
- In the qualitative phase students that dropped out of the course were interviewed, and GTM was used to find reason categories for dropout.
- The theory base of the dropout phenomenon was scrutinised to find theories that give additional pre-defined categories of reasons for adult e-learning dropout (the phase will follow the GTM phase as suggested by [145])
- The phenomenon of *dropout in e-learning* was clarified, based on the categories both generated by GTM and suggested by theory
- A quantitative survey research was be used to find the most important reasons for dropout

The approach is depicted in Figure 17 on the next page.

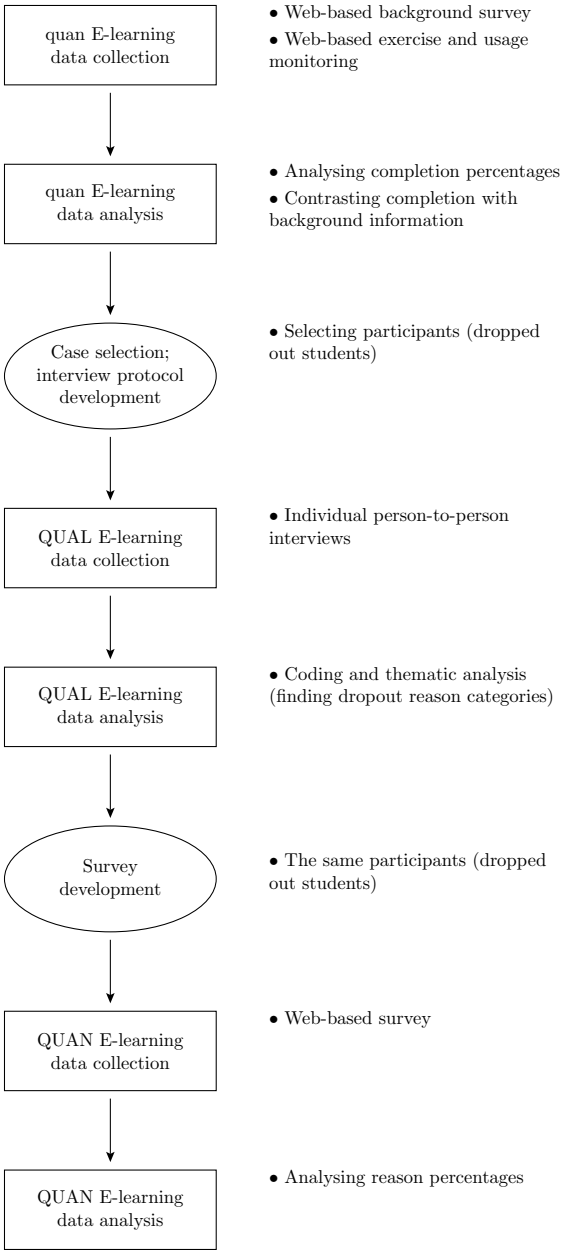

Figure 17: Diagram for Part II

4.5.2 The e-learning course

The e-learning model was *Online Courseware* (OC) as defined in chapter 2.4.3.2. The simple reason for choosing this model over the others was that it was used at the company – for very short courses even teacher presence would be difficult to organise, let alone peer presence. Moreover, as mentioned before, a course with no social interaction can be highly successful when the instruction is targeted at professionals [121].

And last but not least, another reason for using the OC model was that it is the most basic one and can in further studies be expanded with various features to see about their effectiveness in trying to mitigate dropout.

In the initial phase a web-based course on the basics of the JavaScript language was constructed. The duration was similar to a one day classroom-based course to keep the work to a reasonable level. The course was titled "Basics of the JavaScript language". The subject was current and interesting as general knowledge to any programmer, and a prerequisite to many other programming courses. The subject being a prerequisite was important in motivating the students, and using the course as prerequisite was similar to what was presumed to be a common usage for e-learning in the training company of the study case.

The content of the course as shown on the company's public web page is listed in Appendix F on page 157.

The exercises of the course had recently in its classroom format been changed to be as close to real-life use cases as possible, and the same exercises were used on the e-learning course. Using such exercises is in agreement with the notion of "enhancing meaning" in Wlodkowski's framework analysed on page 43.

The course was created using industry standard WordPress platform. All the logging done by the platform was stored on a database at the research's target company's premises to ensure data security.

Before a student could use the system, similar background questions related to prior knowledge, job function and other verbal background information were asked as on the classroom course[22]. The prior knowledge questions were as shown in Table 7.

Table 7: Prior knowledge questions in e-learning

Subject	**Essential**	**Helpful**	**Subject knowledge**
HTML 4	×		
CSS 1/2		×	
JavaScript's basic syntax and libraries			×
jQuery			

A sample of the course user interface is shown in Figure 18 on the next page.

[22]Unfortunately due an error the prior knowledge questions were asked only from the 52 last students out of the total of 147, which got an invitation to the e-learning environment.

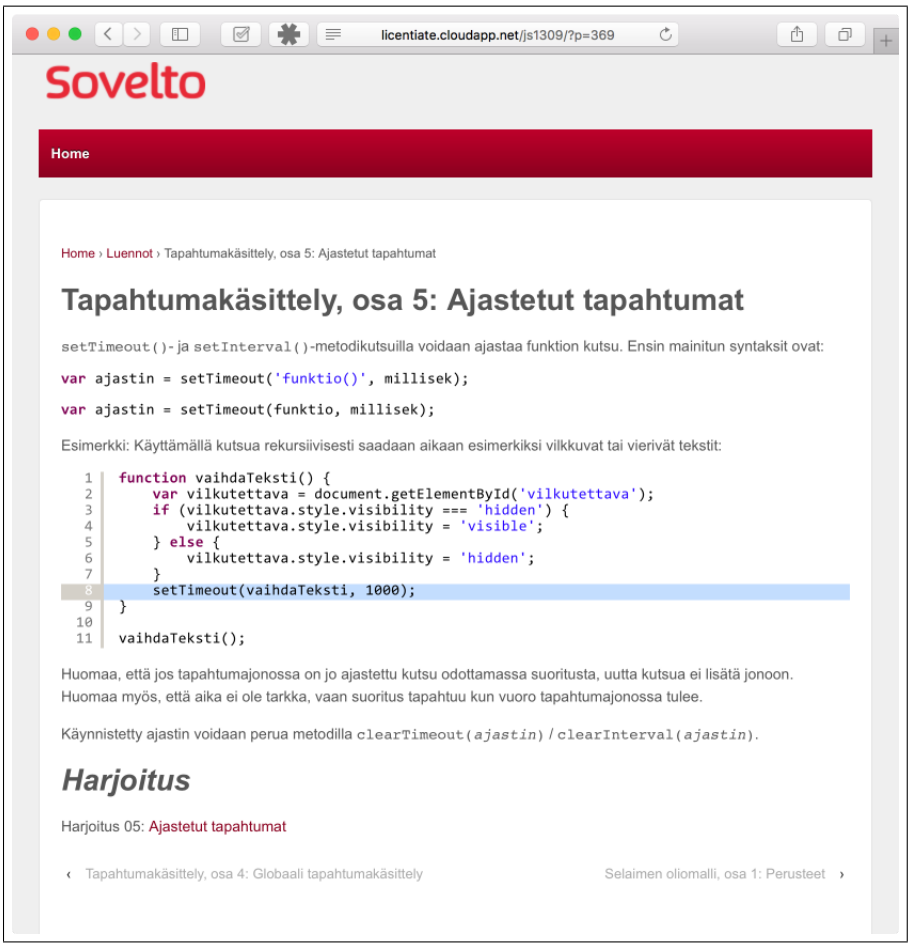

Figure 18: JavaScript e-learning course content sample

The course was offered to customers that were about to attend another course for which knowledge of the JavaScript language was a prerequisite, such as HTML5 programming or jQuery. The setting was problematic, as it could be expected that a sizeable portion of the participants would have the prerequisite information. However the setting also corresponds to an intended and important usage of e-learning in corporate surroundings – making it easy to give advance information to participants and to diminish possible differences in their mastery of course requirements.

Another problem was that of timing: the enrolments to the classroom courses are made quite late – on public courses most of the enrolments happen during the last four weeks before the course, and on company-specific courses the name list is often given by the customer only two weeks before the event. The last changes may happen as close as a day before the actual course, and naturally an invitation to the e-learning course cannot happen before the enrolment time. The too short e-learning study time has manifested itself as a dropout reason in previous research [95, p. 104] and as such the aspect could be an idea for future study.

In the case of this study the invitations for the e-learning course were sent about two weeks before the classroom course.

The user interface of the exercises had similar buttons at the top of the screen as the classroom-based course for the students to report their completion of the exercises. An example of these and about an exercise is shown in Figure 19.

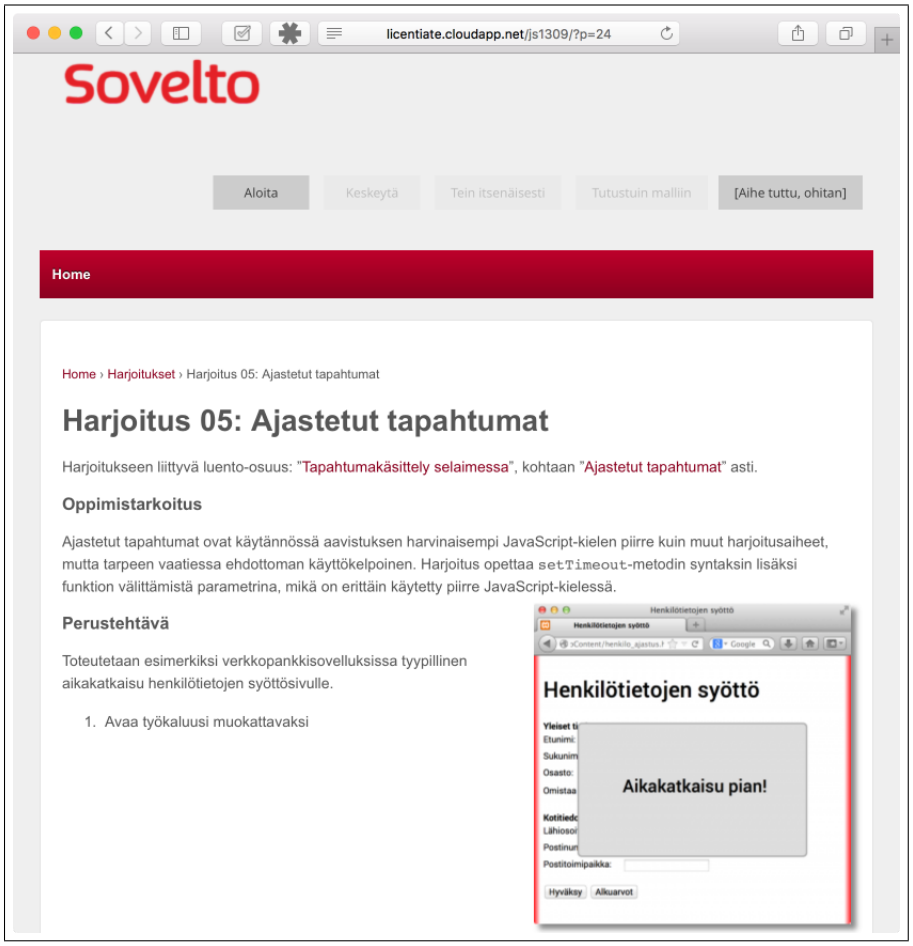

Figure 19: JavaScript e-learning course exercise sample

It was soon found out that the participants did not understand the meaning of the buttons, or otherwise chose not to use them. The course environment was altered to automatically track and time the users' transitions between the web pages of the course content. These transitions could easily be used to calculate how long a user had spent time using the system.

4.5.3 E-learning interviews

Again the interview questions were formed to elicit as open answers as possible – while paying attention to possible problems in the course experience – and the questions were checked by a knowledgeable peer. The question sheet was

not given to the interviewee in order for her to pay more attention to the actual conversation. All the interviews were recorded and later transcribed.

The question sheet is below, continuing on the next page[23].

[23]Translated from Finnish by retaining as much as the original wording as possible, causing some unavoidable clumsiness in the sentences.

Background The interview concerns a licentiate's thesis, where I compare classroom and e-learning teaching in the training of software developers. Such research has been globally performed very little, as the most research of teaching and learning is focussed on schools and universities.
This part of the research is performed as an interview instead of for example a readymade questionnaire – the meaning is to find out more about the strengths and weaknesses of e-learning teaching.
About my own background: I have been training software developers mostly concerning Java server programming for about 18 years.

The questions

1. Why did you participate on the course?
2. How did the e-learning course go in your opinion?
3. Can you think of matters that hindered carrying out the e-learning course in question?
4. Which matters helped in carrying out the e-learning course?
5. Could you think of matters that in your opinion could make *completing* e-learning courses easier? This as generally, regarding any e-learning course?
6. How could the JavaScript e-learning course be made better?
7. Were there any matters not regarding the training organisation, which either positively or negatively affected carrying out the course?
   (a) Could you specify any of these to be related to your workplace
   (b) or external to work?
8. Were you able to concentrate well enough on the e-learning course; were there external disturbances or interruptions?
9. Did you have enough time for carrying out the course?
10. How do you estimate your own prior capability in relation to this e-learning course?
    (a) Were you able to estimate the prerequisites in advance well enough or did there surface any surprises that made completing the course more difficult?
11. Which matters did motivate you to participate in the e-learning course?
12. How did the learning environment of the course function in your opinion?
    (a) More specifically: What functioned well?
    (b) Were there problems at some point?
13. Should something about the course environment have been constructed differently?
14. About the course content: Did some of the subjects feel especially useful?
15. And was some item worthless or was too much time devoted to it? Why?
16. And what aspect of the course did feel difficult?
    (a) Were the difficulties related to new concepts, which were hard to understand, or to solving the exercises?

The questions continued...

17. Which features of the e-learning course were most supportive for learning?

18. Did the exercises support learning?

    (a) If not, why?

19. What was the level of difficulty of the exercises related to your own level of capability?

    (a) And: What was the level of difficulty of the exercises related to the objectives of the course?

20. How do you feel the time should be divided on an e-learning course like this for example between the following aspects:

    (a) teaching new content (theory)

    (b) instructed exercises

3. [a]Now that you have pondered the case via multiple questions, do any other matters come to mind that either hindered or helped in carrying out the course in question?

6. Could you name other matters that could make the learning of such e-learning courses better?

5. Could you name other matters that could make the *completion* of e-learning courses easier?

21. As an extra question:

    (a) Have you yourself done any e-learning courses on any subjects related to software development?

    (b) And other e-learning courses?

22. Any feedback about the conducting of this interview?

[a]The questions 3, 6 and 5 were repeated here, on the grounds that after pondering the subject via the other questions, something new could have surfaced from memory.

4.5.4 E-learning survey

The survey questions were formed from the interview analysis results presented in subsection 5.2.8 on page 109. The questions were formed using the two rules of

1. choosing features related to the *content of the course* and the *e-learning platform* that could possibly be acted upon; and
2. choosing the major *aspects of e-learning* and major *externals aspects* to find out whether these play a more definite role in dropout than the content and platform categories.

The scale is on this page and the questions are on the current page. The user interface is shown in the appendices in Figure 48 on page 147.

Scale:

0. I cannot tell/does not apply to me
1. no effect
2. small effect
3. moderate effect
4. large effect
5. very large effect

E-learning survey

Background

In my research I am looking for features which possibly raise the motivation to complete e-learning courses.

How would you rate the significance of the following aspects for you concerning e-learning completion motivation.

E-learning course content

- Gamification[a]
- Final examination and a certificate after it
- Small tests inside the content that help assess own level
- Content and/or exercises that adapt to own capability
- Voice and/or video content
- Competition with other participants
- Completing a whole application during the exercises
- Story-like content
- Final feedback about success
- Demonstrations, which can be run phase by phase
- Finnish language content

Something else, which, and how important? (You may also comment on the previous items.) *(continuing below)*

[a]Unfortunately the term was not clarified and it is not known how it was understood by the survey respondents.

(continuing from above)

The e-learning platform

- Progress information (e.g. time used or remaining content)
- Feedback about the achievements (from the teacher or the system)
- Communication possibility with the teacher
- Comparison with other participants
- Progress monitoring (the teacher monitors)
- Growable points or other small awards
- Communication possibility with other students (chat and/or discussion board)
- A pleasant user interface

Something else, which, and how important? (You may also comment on the previous items.)

General advantages of e-learning

- Participation is not timed
- Prepared content (vs. googling)
- One can choose on which subjects to concentrate
- One can return to certain subjects, and can search for additional information
- The content can straightforwardly be applied at work assignments

Something else, which, and how important? (You may also comment on the previous items.)

External aspects affecting motivation

- Dedicated time from work
- Reward (e.g. coffee ticket, money, or something else)
- Compulsion
- Completion mark only of a completely finished course

Something else, which, and how important? (You may also comment on the previous items.)

4.6 Trustworthiness

4.6.1 Criteria for trustworthiness

The term "trustworthiness", and the criteria for trustworthiness listed below [136, pp. 26, 209, 296] have been chosen because they have counterparts in both qualitative and quantitative traditions, and thus are well suited for mixed-methods studies. There are naturally other classifications in existence (e.g. [21, p. 181]).

Credibility Whether or not the reconstructions of the inquirer are "credible to the constructors of the original multiple realities". An example question could be: "Have I truly captured the teachers' constructions of the role

of the principal as an instructional leader, rather than my own comprehension of the phenomenon, or something else entirely?". Credibility is especially important regarding social and behavioural research, because most attributes are not directly observable. The related quantitative concept is *internal validity*.

Transferability Transferring of inferences from a specific *sending* context (the research setting) to a specific *receiving* context (other similar settings). The related quantitative concept is *external validity*.

Dependability The extent to which the process of the inquiry is dependable; the ability of the human instrument to yield *consistent* results. If procedures yield dependable results, then they should consistently track variability across different qualitative contexts. Related quantitative concept: *reliability*.

Confirmability The extent to which the product of the inquiry is confirmable, including whether results are grounded in data, whether inferences are logical, whether there is inquirer bias, and so forth. Quantitative: *neutrality* or *objectivity*.

4.6.2 Trustworthiness and epistemological assumptions

The epistemological assumptions were handled in subsection 2.3.3 on page 9.

The quantitative phases of the study – classroom exercise reporting, e-learning usage analysis, and e-learning survey – all try to find an existing and measurable reality. This is naturally limited to what the measurements used did allow the researcher to see.

In contrast to this, the qualitative phases – classroom and e-learning interviews – are limited to what the personal views of the interviewees were, and how well the interviewer succeeded in capturing it.

4.6.3 Techniques for enhancing trustworthiness

A general way of ensuring *all* the facets of trustworthiness is to keep a reflexive journal [136, p. 296]. It is a diary (daily or as needed) of information about the investigator, such as the investigator's possible biases and the methodological decisions the researcher makes.

Ways of ensuring best possible **credibility** are [136, pp. 213, 295–296]:

1. Prolonged engagement
2. Persistent observation (not relevant as observation was not used in the research)
3. Triangulation techniques
4. Peer debriefing: a dialogue with a "disinterested" peer
5. Negative case analysis: an examination of instances or cases that do not fit within the overall pattern of results
6. Referential adequacy: putting aside a part of the raw data and re-analysing it to assess the quality of inferences

7. Member checks: asking members of the social scene to verify the findings

Transferability can be enhanced by *thick description*, which involves making detailed descriptions of the context and other aspects of the research setting so that other researchers can make comparisons with other contexts in which they are working.

Dependability can improved by a *dependability audit*, which concerns the *processes* used. This is done by providing an "audit trail" of documentation (critical incidents, documents, and interview notes) in addition to the reflexive journal [32, p. 34].

A way to improve **confirmability** is via a *confirmability audit*, which is an examination of the *product* of the inquiry to gain confidence that the interpretations are supported by the results and are internally coherent [136, p. 295].

4.6.4 Quality issues in this study

4.6.4.1 Inherent biases Considering the exploratory research aim, there should be no inherent bias in the research towards finding any particular percentages or reasons for dropout. It has to be noted though that as the context was a commercial company, care had to be taken to assure that nothing harmful to business is caused by the study. For example a large-scale study asking for factors that might improve classroom education could give a view that the company is not an expert in its field. Or, as mentioned elsewhere, the existing course feedback after the course could not be expanded as the course time is at premium. Or the e-learning courses could not be freely advertised in order to not steal students from a commercial classroom version of the course.

4.6.4.2 Reflexive journal A reflexive journal was kept, although not started at the very beginning of the study. To allow for easy access, a simple Rich Text Format file was utilised, and it was kept in a cloud storage to allow access from everywhere; these lowered the barrier of writing notes. Every note was dated to show how the study progressed.

4.6.4.3 Credibility: Construct validity Construct validity in qualitative research [21, p. 188] can be thought to be part of credibility.

In the case of this research the definition of "dropout" in the quantitative phases is important, as it guides quite a much of how the study will be conducted. This will be analysed in the relevant later sections.

The qualitative phases will concentrate on finding the reasons for dropout, which are always subjective. Thus while conducting interviews regarding the reasons, several reminiscent questions were used to ask about certain concepts to find out whether the concepts were equivalent between the interviewer and the interviewee.

Considering the list of ways of ensuring trustworthiness given in subsection 4.6.3 on the preceding page, the following were used:

- Prolonged engagement: Both the classroom and e-learning parts of the study were conducted over a duration of several months or even years. Moreover the researcher had over 15 years of experience in the field of further education as presented in the teacher descriptions in Appendix D on page 152.

- Triangulation techniques: Both the classroom and e-learning parts of the study used mixed methods with a major idea of providing methodological triangulation.
- Negative case analysis was used most prominently in classroom interviews as also a student that was not a dropout was interviewed.

The social features of peer debriefing and member checks were not utilised due to the solitary nature of the research.

Concerning the research participants, *dropout* can be personally stigmatising, especially as the study concerned courses that are related to the occupation of the students. It can be assumed that they tend to externalise the problems causing drop out, e.g. from a lack of sufficient previous knowledge about the subjects of the course to lack of interest or lack of time. This warranted special attention when the interviews were conducted.

4.6.4.4 Transferability Thick description has been attempted to be followed at all the qualitative stages of the study. The classroom and e-learning settings have been described both in the main text and more thoroughly in the appendices. The appendices also contain the classroom course descriptions in Appendix E on page 154, and e-learning course content listing in Appendix F on page 157 to give the reader a more thorough understanding of the study context.

4.6.4.5 Dependability The report itself contains samples of the analysis process, and the full versions are available online: the interview coding documents of both the classroom and e-learning versions at `http://bit.ly/1TL648O`, and classroom background and exercise comment coding at `http://bit.ly/1UiKurJ`. Unfortunately due to the interviews being conducted in Finnish major parts of the documents also are in Finnish.

4.6.5 Credibility and dependability related to the classroom analysis

4.6.5.1 Credibility and dependability related to the classroom exercise reporting

Credibility issues and countermeasures When dropout is measured via exercise completion as in this study, a teacher can tremendously affect classroom dropout by changing the exercises. In this study it was known that no changes were made, and in fact the full meaning of exercise completion in relation to this study was not highlighted to the teachers.

A clear issue in credibility is the possibility of error in grading the prerequisite knowledge, and to lesser degree in grading the prior knowledge. When grading, the figures were thus double-checked to limit the possibility of a mistake.

As already mentioned in the trustworthiness section 4.6 on page 68 and dropout definition section 4.4.1 on page 50, the definition of dropout is of major importance. This facet will thus be paid specific attention in the result analysis sections.

Dependability issue countermeasures All participants were shown how to use the software. At the same time a brief introduction was given about the research. An instruction leaflet containing the same information was handed out to everyone; the leaflet is shown in Figure 49 on page 148.

When other teachers were involved, they were first instructed about how to use the software and additionally given a separate instruction sheet. Also if feasible the researcher stood in the class until the first exercise and did then give the briefing himself.

The researcher did remind the students to use the tool especially during the first day. Other teachers were recommended to do the same, but this could not be verified.

Not everyone used the reporting tool, but the teacher checked that most of them did successfully complete the exercises thus reducing the possibility of a major bias.

4.6.5.2 Dependability issues related to the classroom interviews

As clarified in subsection 5.1.4.1 on page 88, in all 16 students were classified as dropouts. Ten of these were students of the researcher. To avoid biases of trying to please the interviewer these could not be chosen to be interviewed by the researcher. Using other interviewers was not not utilised due to several reasons. Firstly, participations are company confidential information and could not be passed on to external interviewers. Secondly, the initial thought was to perform all the interviews face-to-face, and due to the high time consumption of such an approach, no interviewers were asked for within the company personnel. And finally, even if separate interviewers would have been found, a noteworthy level of bias would have remained as the interviewees would have known about the researcher and the teacher being the same person.

In all six interviewees were discovered to be interviewed. Due to this relatively low number there exists a possibility that something new could have been obtained by increasing the count. As explained in more detail in subsection 5.1.4.1 on page 88, the phenomenon was rare, and unfortunately there also were difficulties in contacting some of the dropout candidates. However as it turned out in the interview analysis the responses followed for a great part similar lines. So it is unlikely that anything drastically different might have been obtained from a greater amount of interviewees. It has to be noted though that no interviewees with an involuntary participation could be found – something new could have been obtained from them.

Another issue is that the reasons given by participants may be biased and are likely to point to other directions than the participant [143] [95, p. 97]. This was attempted to be countered by wording the questions to point to various forms of difficulty.

4.6.6 Credibility and dependability related to the e-learning phase

4.6.6.1 E-learning platform usage

The usage times were counted from page-to-page transfers and page closing. The real usage is somewhat lower, as for example changing to another computer program cannot be reliably analysed. To counter this the pages were made small, about only a computer screen long, so that they could be easily read and page transfers would happen relatively often.

4.6.6.2 E-learning interviews As in classroom interviews, the reasons given by participants may be biased. This time the amount of interviewees was high; thus a bias caused by a low number of interviewees is very unlikely.

Some interviewees with short usage durations mentioned that they could not remember their e-learning course participation. Based on this information, and on the fact that students who did not log on to the course at all could not know anything about it, such students were not interviewed. When the results were later analysed, the thought arose that it could have been interesting to find out why they did not at all visit the e-learning system. Unfortunately at that time it was too late to contact them, as a very long time had already passed since the courses had been taken place.

4.6.6.3 E-learning survey It is worth noting that the scale of the e-learning survey did not include a possible negative effect of a given feature. Adding such a scale might have given even more precise results, as for example someone might have considered gamification to actually hinder her or his study performance.

The aspects, which were asked about from the participants concerning e-learning dropout did arise from the interviews conducted with the 19 study participants. It is possible that some other features could be found by widening the amount of interviews still further.

5 Results

5.1 Results of dropout in classroom courses

5.1.1 Quantitative analysis of classroom courses

Analysis was performed on courses from four different teachers including the researcher. The teachers and the courses lectured by them when collecting data for this study are presented in Appendix D on page 152. A relatively similar teaching style – a lecture followed by an exercise or exercises – was utilised by all of them. This was checked by the researcher to visit at least one of each teacher's courses during the over ten years that they worked together.

The number of courses analysed is shown in Table 8, the researcher himself being teacher number 1. The reporting software was used on a number of additional courses from teachers 2–4, but unfortunately these had several problems and had to be omitted from the analysis – altogether 61 courses were inspected but only 43 could be analysed. The reasons varied, for example teacher number 4 did not add the prior knowledge or even sufficient prerequisite knowledge information to many of his courses and thus eight of the cases and one course (the course is not listed in the table) had to be omitted. In the case of teacher 2, three of his courses had only tutorial style, extremely short exercises which could not be used in the research.

Table 8: Classroom courses analysed

Teacher	Courses	Students
1	33	183
2	4	15
3	3	18
4	3	18
Total	**43**	**234**

Altogether 16 students had an exercise completion percentage of below 25, which could be counted as dropout. These will be discussed more thoroughly below in the next paragraphs.

5.1.2 Quantitative analysis of classroom reporting

All of the analyses were done using IBM SPSS Statistics version 23.

Essentially three figures from the background information could be used for statistical analysis:

- Prerequisite knowledge, an ordinal number from 1 to 4, treated 5.1.2.2 on page 76
- Prior knowledge, an ordinal number from 1 to 5, 5.1.2.3 on page 78
- Participation voluntariness, a nominal number from 1 to 5, 5.1.2.4 on page 79

5.1.2.1 Grading the exercise completion The completion rates were initially decided to be classified with a Likert-style grading from 1 to 5. This should be precise enough, but not too precise as coding the completion rates necessarily involves personal decisions. The scale used was as follows:

1. No or almost no exercises completed (less than 20%)
2. Some exercises completed (20–40%)
3. About half of the exercises completed (40–60%)
4. Major part of the exercises completed (60–80%)
5. All or almost all of the exercises completed (80–100%)

After some statistical handling done, the coarseness of the categories turned out to give no benefits. Thus the material was analysed again and completion percentages were calculated instead; these figures are used below.

The percentages are shown in Figure 20. As can be seen there, almost forty percent (37% to be exact) of the students completed all of the exercises, and 65% of the students had completed at least 3/4 of their exercises. On the other hand, only 7% had a completion rate of less than 1/4 of the exercises, and only eight students (3%) did not complete any exercises.

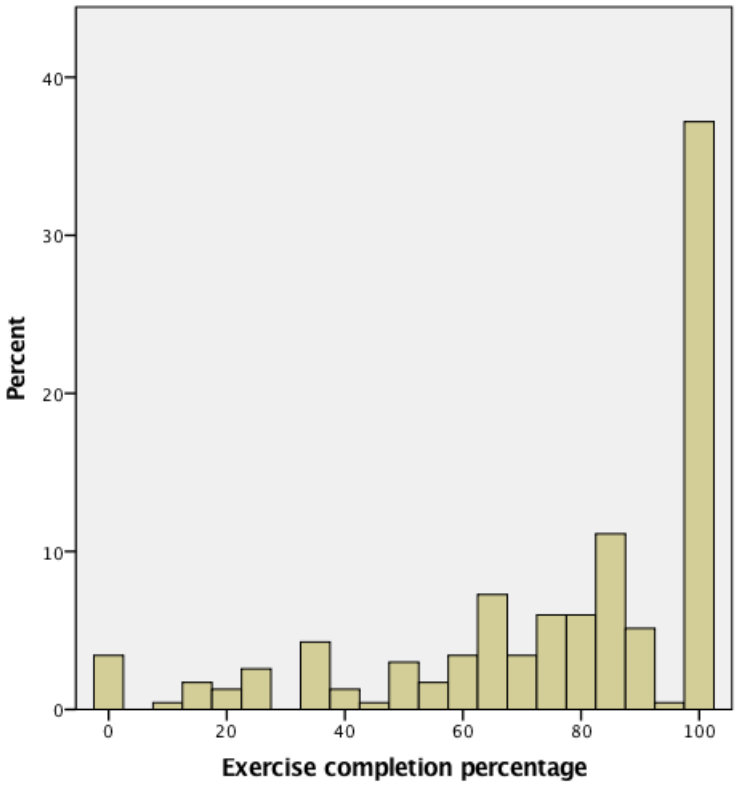

Figure 20: Exercise completion percentages

So, what is the amount of dropout in the classroom? When the question is considered, the following aspects have to be considered:

1. The completion percentage counts only exercises that were completed without consulting the sample code for a given exercise. In many cases the student did gain the information even if they had to resort to the samples as was brought into light during the interviews (best summarised in Table 18 on page 96) and when exercise comments were analysed (see subsection 5.1.3.2 on page 85).

2. Even with a total non-completion of an exercise the student had read the exercise for at least some degree, and in most cases the teacher goes through the exercises in front of the class before continuing lecturing. So knowledge is gained even without completing an exercise.

Given these additional notions it can be argued that the dropout in classroom instruction is small indeed, in the vicinity of $0 - 5\%$.

5.1.2.2 Prerequisite knowledge Relevant *prerequisite knowledge* related to the course requirements are coded on the ordinal scale of[24]:

1. No or insufficient relevant prerequisite knowledge

2. For some parts insufficient relevant prerequisite knowledge

3. Sufficient relevant prerequisite knowledge

4. Excellent relevant prerequisite knowledge

As mentioned in the research description, the prior knowledge values were given by students in the background questions (see subsection 4.4.3.1 on page 53), and those numbers were combined by the researcher to a single figure representing prerequisite knowledge, as explained in the paragraph "Notes on background information" on page 55.

Prerequisite knowledge is plotted against exercise completion percentage in 21 on the next page.

[24]Less categories than in the previous list are used, as information about the prerequisite knowledge is based on self-report and its relevance (according to the instructor) is a subjective view – also a given piece of prerequisite knowledge may not affect the whole of the course.

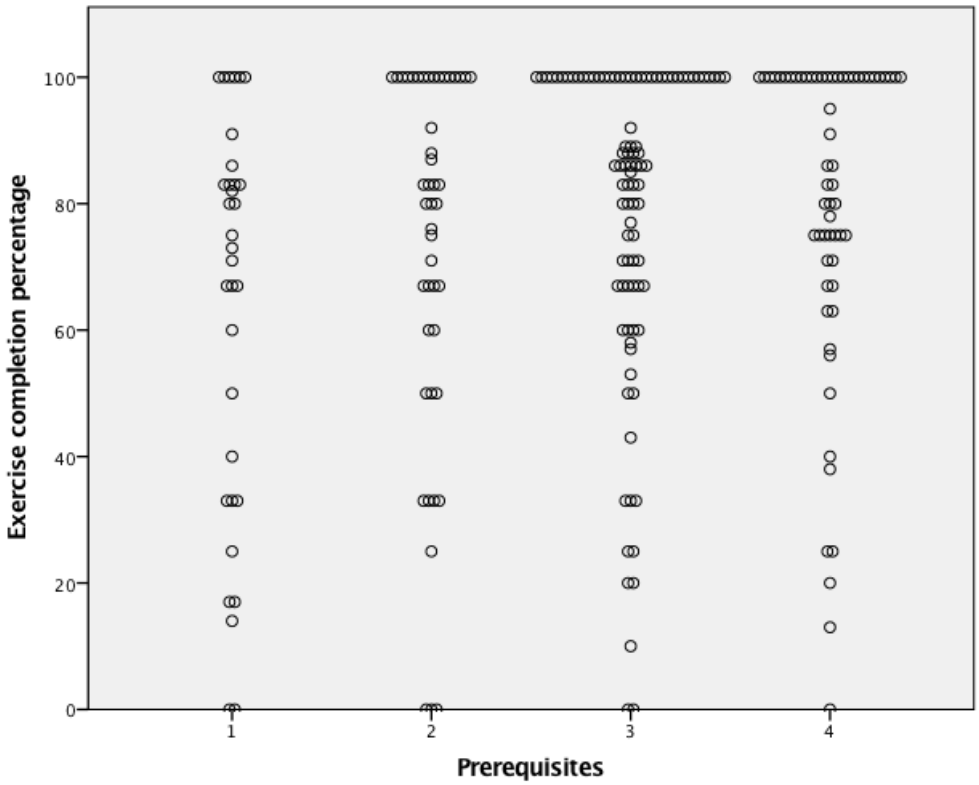

Figure 21: Scatter plot of prerequisite knowledge and exercise completion
Horizontal scale: 1 = *insufficient knowledge* ... 4 = *excellent knowledge; see page 76*

An increase in prerequisite knowledge was weakly associated with an increase in exercise completion percentage when a linear relation was analysed, Spearman's $\rho_s\,(232) = .18$, $p = .007$ [25]. However as the scatter plot of Figure 21 shows, when a student had sufficient prerequisites expressed as values 3 or 4, the exercise completion percentage is heavily clustered towards the value of 100. When the prerequisites are insufficient (value 1), no heavy clustering is evident.

Considering prerequisite knowledge another analysis is warranted: when a course is a very basic one, it can be that the prerequisites are the same as the course content. In the case good prerequisite knowledge basically means prior knowledge, and moreover that is is extremely easy to complete the exercises. Thus Figure 22 on the next page shows the data of the previous figure with nine such basic courses having altogether 50 participations removed.

[25] The validity of using this method was checked with a statistician.

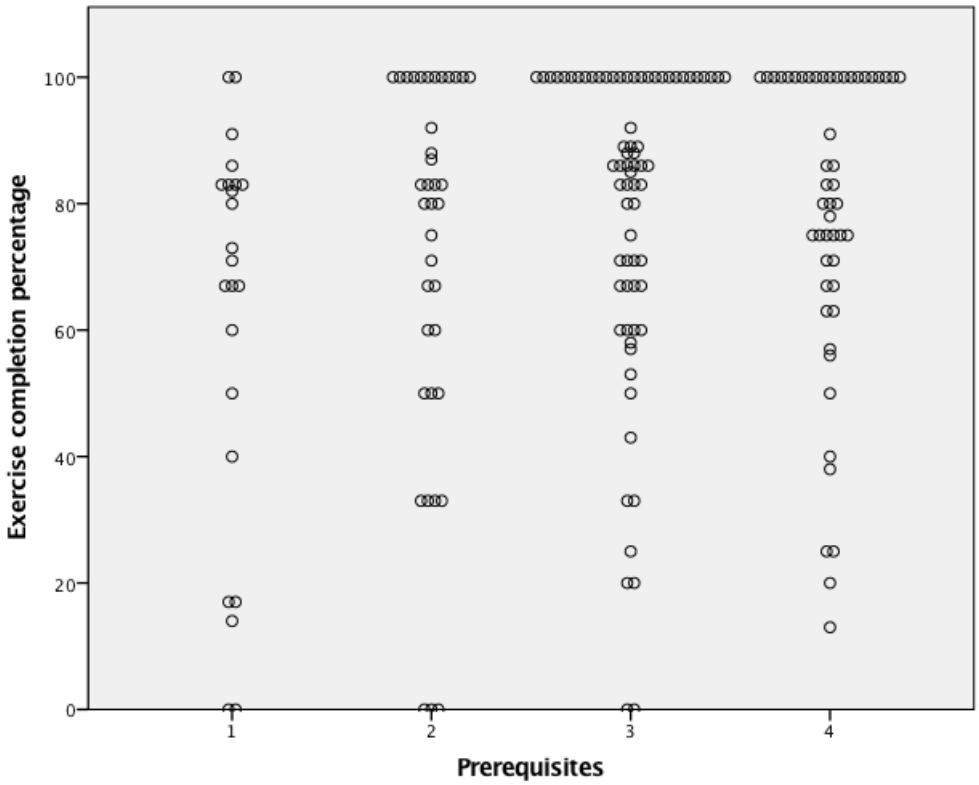

Figure 22: Scatter plot of prerequisite knowledge and exercise completion (no basic courses)
Horizontal scale: 1 = *insufficient knowledge* ... 4 = *excellent knowledge; see page 76*

An increase in prerequisite knowledge was almost similarly weakly associated with an increase in exercise completion percentage as in the previous case, Spearman's $\rho_s\,(182) = .17$, $p = .02$. The data cannot tell the reason for similarity, but it may well be that the students tend to have a certain ways of checking – or not checking – that they possess the prerequisite knowledge needed on a given course. It is also possible that the teachers have a tendency to even out differences between groups so that always a certain percentage of the students complete the exercises.

5.1.2.3 Prior knowledge *Prior knowledge* differs from prerequisite knowledge in that many subjects require some prerequisite skills (for example knowledge of the Java or C# languages), but no knowledge about the subject itself (for example Java EE or SharePoint programming). Prior knowledge about a subject is based on the background answers given by students as explained on page 53. The information was combined to a single figure on the ordinal scale of 1–5 by the researcher. On this scale number 1 means no prior knowledge and number 5 means strong prior knowledge.

Prior knowledge is plotted against exercise completion percentage in Figure 23 on the next page.

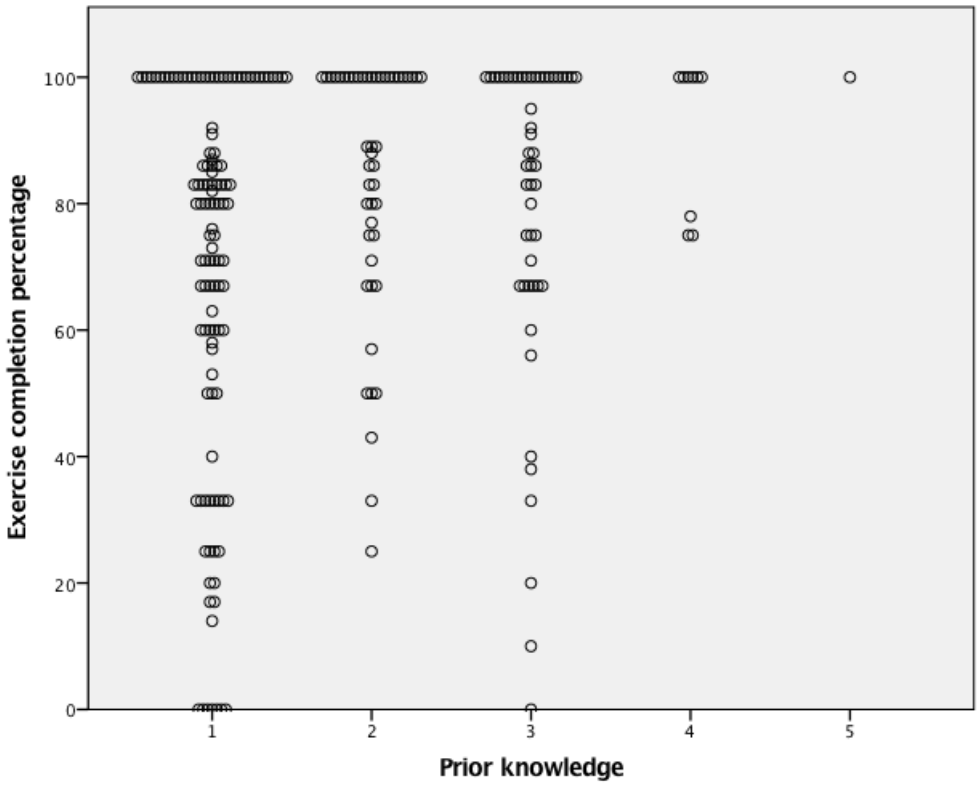

Figure 23: Scatter plot of prior knowledge and exercise completion
Horizontal scale: 1 = *no knowledge* ... 5 = *strong knowledge; see page 78*

An increase in prior knowledge was weakly associated with an increase in exercise completion percentage, Spearman's $\rho_s\,(224) = .22$, $p = .001$. In this case when the scatterplot is analysed, it is worth noting that no one with a strong prior knowledge (values 4 or 5) had an exercise completion percentage of less than 75.

5.1.2.4 Participation voluntariness *Voluntariness* in attending the course is coded on a nominal scale of 1–5. Although the level of voluntariness is rising as the number is rising, it definitely cannot be treated as an ordinal scale. Participation voluntariness is plotted against exercise completion percentage in Figure 24 on the following page.

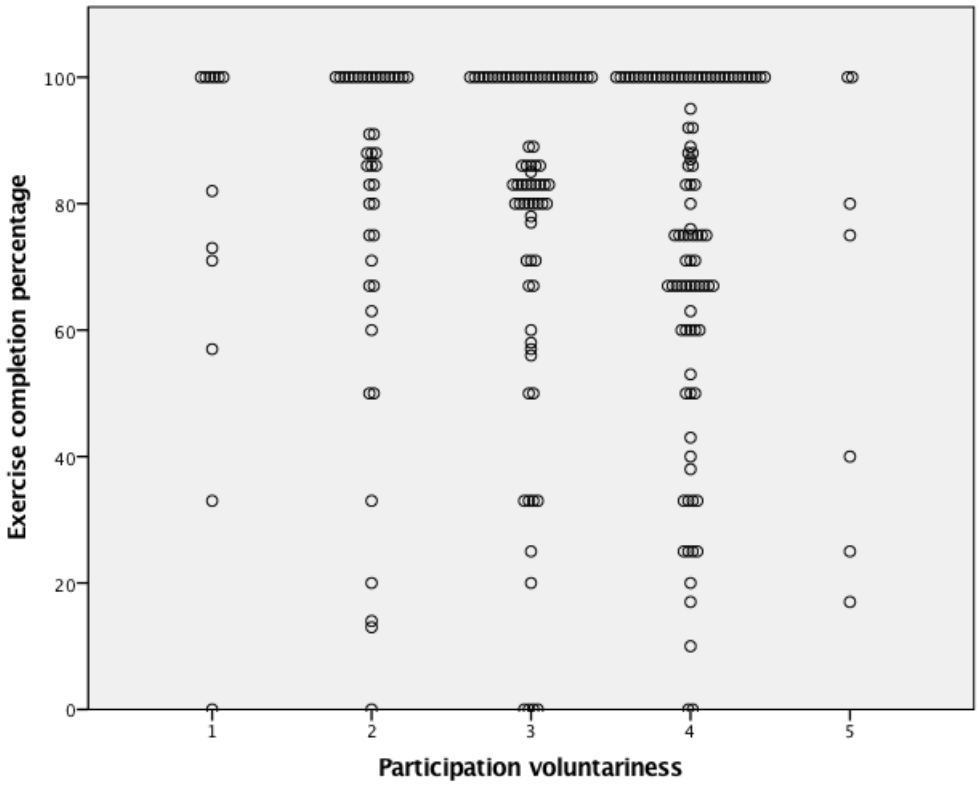

Figure 24: Scatter plot of participation voluntariness and exercise completion
Horizontal scale: 1 = involuntary, ordered to participate ... 5 = completely voluntary, self-paid; see page 54

An increase in participation voluntariness was not significantly associated with an increase in exercise completion percentage, Spearman's $\rho_s\,(232) = -.10$, $p = .12$.

5.1.2.5 Linear fitting In addition to analysing the monotonic relationship using Spearman's ρ_s, a linear fitting was examined to be used with the prerequisite, prior knowledge, and voluntariness values. The fitting was unsuccessful as the requirements for using a linear model were not met – this is evident by visually analysing the scatter plots above.

5.1.2.6 Voluntariness vs prerequisites or prior knowledge An interesting aspect to analyse is that if a student has not been volunteering to attend a course herself, would she have on the average better or worse prerequisite or prior knowledge – the thought being here that if a superior has been giving an order to attend, does the superior know the situation well enough.

Scatter plots of these cases can be found in Figure 25 on the next page and Figure 26 on page 82, involuntary participation marked with the number 1.

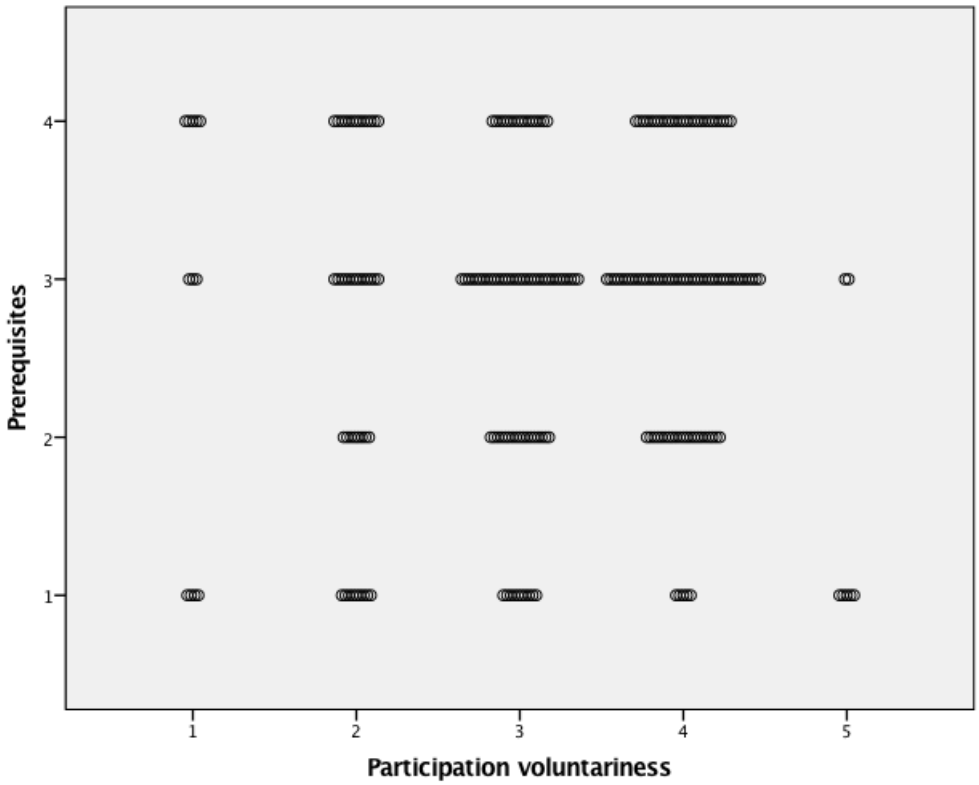

Figure 25: Scatter plot of participation voluntariness and prerequisites
Horizontal scale: 1 = *involuntary, ordered to participate ...* 5 = *completely voluntary, self-paid; see page 54*
Vertical scale: 1 = *insufficient knowledge ...* 4 = *excellent knowledge; see page 76*

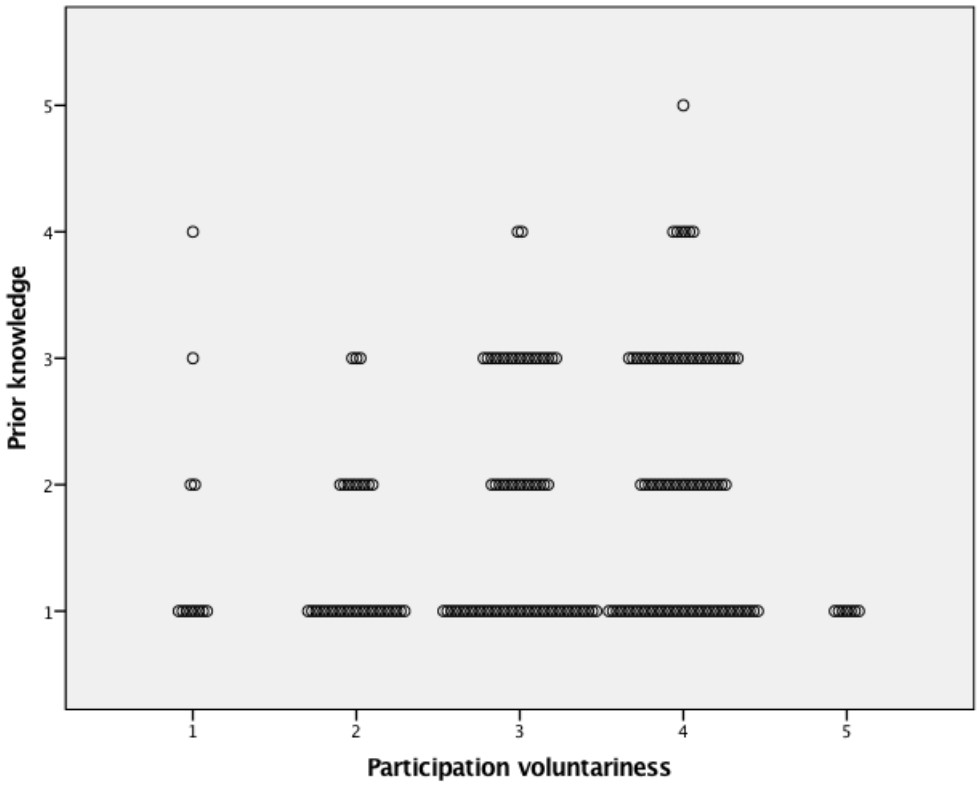

Figure 26: Scatter plot of participation voluntariness and prior knowledge
Horizontal scale: 1 = *involuntary, ordered to participate ...* 5 = *completely voluntary, self-paid; see page 54*
Vertical scale: 1 = *no knowledge ...* 5 = *strong knowledge; see page 78*

No deductions that involuntary participation would mean worse prerequisite knowledge than those with voluntary participation can be made, Spearman's $\rho_s\,(232) = -.02$, $p = .77$.

On the other hand, based on the results of this study, persons with involuntary participation tend to have slightly better prior knowledge of a subject, Spearman's $\rho_s\,(224) = -.17$, $p = .01$. A plausible explanation could be that if a person has good prior knowledge of a subject, she or he is less likely to attend a course on it.

5.1.3 Qualitative analysis of classroom reporting on dropouts

The classroom reporting also included qualitative features. Prominent are the questions about the background of the student, but the exercise reporting software also had a way to comment about the single exercises.

As mentioned in section 5.1.1 on page 74, in all 16 students were classified as dropouts. The textual information given by them was analysed using steps *inspired by* GTM to ensure a formal way of treating the texts. It is important to note that no theory building was attempted – GTM was only used to give pre-defined steps to content analysis.

As the texts were not open texts but answers to rather precise questions with a very minimal amount of content, selective coding phases were combined. Also – given the limitations in answers due to the pre-set questions – there could be no aim of creating theory with relationships and thus the theoretical coding was omitted. The steps used are depicted in Figure 27.

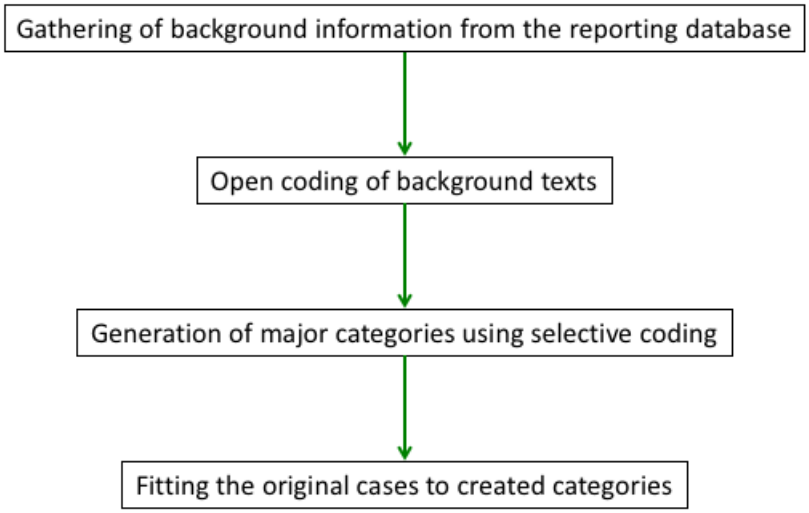

Figure 27: Classroom background coding steps

An example of the *open coding* phase is given in Table 9 on the next page.

Table 9: Classroom background example: Open coding

Excerpt from text	**Open code**
Related to testing automation I want a broad overview related to Java (background transcription 1)	Reason for attending
Slow proceeding speed if possible, as novices are present. (background transcription 1)	Wish for the manner of teaching
Participation on the course is actually not relevant to my work as I use different techniques. I want to take part on the course purely out of own interest as I find new things interesting, (background transcription 2)	Reason for attending
and I may be able to utilise the knowledge gained in some way in my work, or at least in my own personal software applications. (background transcription 2)	Knowledge usage
Learning new things is always a plus and in some way it is bound to broaden my working habits. (background transcription 2)	Reason for attending
To understand the HTML5 technique and its benefits for the customer. (background transcription 4)	Learning desire
I hope I can tag along even if my Java knowledge is not very strong. (background transcription 6)	Fear of ineptitude

After open coding, selective coding was used to find major categories and their subcategories. This time there were only eight open codes found due to the aforementioned pre-set questions, and thus there was no need for combining synonyms as in full GTM, and finding the major categories was relatively easy. The category structure is presented in Table 10.

Table 10: Classroom background: Selective coding

Major category	*Reason for attending*	*Hopes and fears*	*Background*
Categories	Knowledge usage	Learning desire	Knowledge background
	Extending knowledge	Wish for the learning environment	
		Wish for the manner of teaching	
		Content wish	
		Fear of ineptitude	

5.1.3.1 Background information statements of the dropped out students As shown above, two major categories could be extracted from the background information, *Reason for participation*, and *Hopes and fears*; the *Background* major category contained only a single category with a single text excerpt. These are elaborated below.

As these statements were asked from all the 16 dropped out students, the results have been presented below with the citation counts in a quantitative

research fashion. However it is good to bear in mind that the categorisation of the statements and the related counting of citations has necessarily involved interpretations of the content by the researcher, as shown above especially in Table 9 on the previous page.

Reason for participation A category containing most individual statements is *Knowledge usage*. A single most cited statement in this category is "Known applicability at work" (6 citations) and the second most cited statement is "Possible applicability at work" (5 citations). The statements did not overlap, i.e. no person did mention both of the statements. In summary and not surprisingly, applicability at work is by far the most important reason for participation.

Still related to the previous category of *Knowledge usage* is "personal use", for example creation of private web pages.

In a second category – named *Extending knowledge* – the most cited statement is "familiarising oneself with a new technique" (with no mention of applicability at work). Two more statements are "possibility of getting new work assignments", and "learning a new technique for applying for work".

Hopes and fears All of the most cited statements could be found in one subcategory: *Learning desire*. The statements were "learning the basics" (5 citations), "Learning the technique" (4 citations), "learning new things" (3 citations), and "understanding the benefits (possibilities and usage)" (5 citations). The first three statements did not overlap. There was overlap between the "understanding the benefits" statement and all of the three learning statements however – only one student mentioned "understanding the benefits" without also mentioning a learning desire.

"A broad overview" and a "view on tools" were statements belonging to the *Learning desire* subcategory. The first one can be argued to be the same as "understanding the benefits" but the wording is too dissimilar. A "broad overview" statement does not overlap with the other statements in the *Learning desire* subcategory.

Other mentions belonged to the *Content wish* subcategory as the statement "practical examples", and belonging to the *Fear of ineptitude* subcategory the statement "hopefully can tag along even if the prior knowledge is not very strong".

Summary Applicability at work is clearly the most important reason for taking part on a course. An other reason worth mentioning is the possibility of gaining new work assignments, either at the same workplace or even finding new work.

Remembering that these statements came from the 16 students analysed as dropped out, it is worth noting that in all eight students only hoped to either learn the basics, understanding the benefits, or getting a broad overview. So about half of the dropped out students did not aim to get thorough understanding from the courses in the first place.

5.1.3.2 Exercise comments Only 9 out of the 16 dropout students had given any comments related to the exercises. An example of the student user

interface in giving comments can be seen in Figure 28.

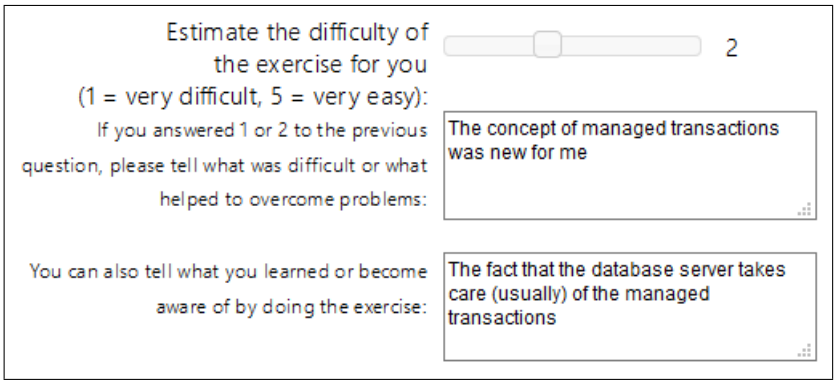

Figure 28: Classroom exercises: Student user interface

Again, to ensure consistent treatment, these were analysed using steps inspired by GTM. These are shown in Figure 27 on page 83. An example of the *open coding* phase is given in Table 11.

Table 11: Classroom exercise comment example: Open coding

Excerpt from text	**Open code**
I familiarised myself with the example as I thought that I do not possess the know-how, but the ignorance was due to tools getting stuck each after another (background transcription 2)	Tool problem
I did not realise anything else but that we are doing an exercise where installing software is the main point. It did not bring any such information that I could think of as beneficial. (background transcription 2)	Non-motivating exercise
jQuery was new, and I did not even try to guess its syntaxes. (background transcription 3)	Unknown technique
There has been a lot of new information, "digestion problems" (background transcription 6)	Amount of new lectured content
Again I had to search material for those stumbling blocks like missing parentheses and typos. (background transcription 9)	Too demanding exercise for skill level

After open coding, selective coding was again used to find major categories and their subcategories. This time there were nine open codes found; finding the major categories was relatively straightforward. The category structure is presented in Table 12 on the next page.

Table 12: Classroom exercise comment: Selective coding

Major category	*Gap between student's current knowledge or skills and the course content*	*Exercise or exercise environment*
Categories	Time problem	Exercise error
	Carelessness problem	Tool problem
	Amount of new lectured content	Non-motivating exercise
	Too demanding exercise for skill level	Unknown technique
	Partial completion	

5.1.3.3 Exercise comment statements Two major categories were found in the exercise comments, namely *Problems caused by lack of skills*, and *Exercise or exercise environment*. These are treated in the next paragraphs. Due to low volume of comments also single statements are mentioned.

Gap between student's current knowledge or skills and the course content This time the category of *Too demanding exercise for skill level* was clearly the most cited one with four different statements. The statements did vary between just "too difficult", "problems with the basic syntax", and "lack of prerequisite knowledge of the language". An unifying feature seems to be that even giving considerably more time for the exercise would not have helped in solving it. In contrast to this, the only statement in the *Time problem* category was such that giving more time would most likely have helped. The single statement in the *Partial completion* category did not give enough information if it was a matter of skill or time.

The other statements had a single mention of *Carelessness problem* when the student had closed a needed server in the exercise. The last statement was that the student could not cope with the *Amount of new lectured content* and this caused problems when trying to cope with the exercise.

Problems caused by exercise or exercise environment In this main category all the categories had two or three mentions.

Errors were the most prominent factor, either *Exercise errors* – in both cases errors in example code to be copy–pasted – or *Tool problems* where the used software tools hung, crashed, or did otherwise not work as they should have worked. In this case both the mentioned exercises errors manifested themselves on a course that was using third party course material.

Three statements fell to the *Non-motivating exercise* category. Two of these detested the exercise being full of only copy–paste instructions, and one did not like that a single exercise contained too many software installations.

In two cases an *Unknown technique* – that is, a technique that was prominently used in an exercise but that was neither listed as a course prerequisite

or taught during the lessons – caused problems too steep to be overcame.

Summary When thinking about the factors that have an effect on exercise non-completion, the major category names of *Problems caused by lack of skills*, and *Exercise or exercise environment* alone speak volumes. When thinking about remedying the situation, the first calls for better informing the students about the course requirements, or even trying to raise their level of competence prior to the course. The latter is more in the hands of the teacher. Either the teacher should try to make the exercises as motivating and error free as possible when producing them, or the teacher should maybe create an errata about common problems when using third-party content.

5.1.4 Classroom interview results

5.1.4.1 Interview participants Altogether 16 dropouts were revealed when the reporting application results were analysed. Ten of these were students of the researcher, and to avoid biases of trying to please the interviewer could not be chosen to be interviewed. Six students were from other teachers and thus could be interviewed. Two of these dropping outs happened over a year before the first interviews were planned to be conducted. These two students were not contacted as forgetting about the course would be an issue. One student would have fitted the time frame of the interviews well, but the teacher had unfortunately lost the name information of the participants of that course and thus the student could not be contacted. This left only three students from other trainers to be contacted. Thus the trainers were verbally asked if any of their students could be classified as "dropouts" due to difficulties in the exercises. Two additional dropouts were selected this way for the interviews.

So, eventually five dropout candidates from two different teachers were found, and fortunately all were willing to be interviewed. Additionally one non-dropout candidate was drawn by lottery to check if anything else could be learned.

The average duration of interviews was 16.5 minutes, with a standard deviation of 4.7 minutes.

The courses are listed in Table 13 on the following page along with some basic information about the students. The course descriptions can be found in Appendix E on page 154.

Table 13: Classroom interview courses

Interview	Teacher	Subject	Prerequisites	Prior knowledge	Voluntariness[e]
1	4	ASP.NET MVC	5	3[a][b]	4
2[c]	4	ASP.NET MVC	4	[b]	4
3	4	C# and .NET Framework programming	3[d]	3[d]	4
4	4	C# and .NET Framework programming	1	1	3
5	4	20486 Developing ASP.NET MVC 4 Web Applications (Microsoft's course material)	4	[b]	2
6	2	20488 Developing Microsoft SharePoint 2013 Core Solutions (Microsoft's course material)	2	3	4
(a)	Deducted from the interview				
(b)	Unfortunately the teacher had not added prerequisite knowledge items to the questionnaire of the course				
(c)	Not a dropout				
(d)	The prerequisites on the questionnaire were either misunderstood or accidentally filled incorrectly. The correct number would be 1 to both columns.				
(e)	2: Employer's/superior's order, after student's own willingness had been inquired about 3: Student's own activity and employer's/superior's stake had about equal effect on the decision to participate 4: Student herself was the active applicant and employer/superior agreed to the participation decision after having been asked (Full list on page 54)				

5.1.5 Analysis

The interviews were transcribed and then analysed using GTM – this time the full version instead of a shortened one used with the background and exercise information. This was made both to ensure a thorough and documented way of analysation and also to build theory about the phenomenon. The process is shown in Figure 29 on the next page.

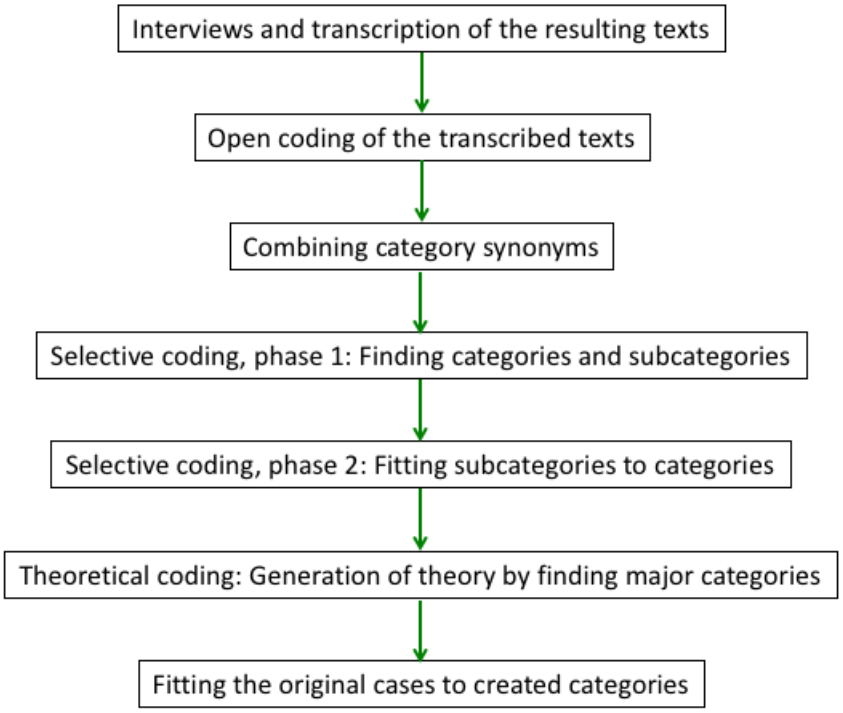

Figure 29: Full version of GTM [145]

An example of the *open coding* phase of GTM is given in Table 14.

Table 14: Classroom interview GTM example: Open coding

Excerpt from text	**Open code**
It would be good to have a practical example, like from real life, like that they're not always such basic things. From a bigger project for example. (classroom transcription 1)	Wish concerning content
I had already familiarised myself with it, like, for me the tool was familiar, and then I had somewhat studied and worked with it. (classroom transcription 1)	Prior knowledge
I would have wished more of such exercises where one does oneself (*vs. exercises with copy–paste content*) (classroom transcription 3)	Wish for exercise type
I think that it is not worth going too much into finesse, it is better to teach the basics at a leisurely pace. (classroom transcription 3)	Wish for time usage
Well, the whole programming language starting from the syntax was alien to me, that was to reason to participate on the course. (classroom transcription 4)	Reason for participation

Finding synonyms An example about finding synonyms is shown in the following list:

- Positive content feature; synonyms: useful content feature, useful content
- Wish for means of teaching; synonyms: learning style wish, lecturing style wish
- Wish for time usage; synonyms: division of time usage, wish for time usage division, ratio of time usage
- Wish for exercise types; synonym: wish for the manner of doing exercises
- Home assignments; synonym: prior assignments

Selective coding Results of the selective coding phases are shown in Table 15 on the next page.

5.1.6 Emergent theory from the interviews

Two major categories can be seen when the whole concept of *Dropout in classroom instruction* is considered: *Dropout reasons* and ways of combating it, which can be named as *Potential persistence aids*. Related to both of these is the category of *Reason for attending*.

The following snippets contain examples of how these were voiced out in the interviews[26].

> "This training had been reserved for another fellow, but he left for another company. So the participation was not from my direct need." (*reason for attending; dropout reason*)

> "The subject was such that I myself wanted to get to this course." (*reason for attending; potential persistence aid*)

> "What was taught gives a starting point for learning new things." (*benefit; potential persistence aid*)

> "There was some C# syntax, which was not very familiar, so that working the lab in a way stopped there. I cannot write this code." (*dropout reason*)

The categories called *Means of teaching* and *Means of studying* can be combined – they are separate features but interrelated. *Speed* is a feature that was so often mentioned that it is included in the same name.

> "Quite much time was used for exercises that were somewhat copy–paste, which I cannot see as very beneficial." (*means of teaching*)

> "So that I understand the pieces of information, so that I can examine the exercises after the course." (*means of studying*)

> "I could have sat there another day, so it could have progressed slower." (*speed*)

[26] Wordings abbreviated and filler words from speech removed, while retaining meaning.

Table 15: Classroom interview GTM: Selective codes

Major category	*Content*	*Level of difficulty*	*Means of teaching*	*Means of studying*	*Prerequisite knowledge*
Categories	Extent of content	Difficulty of theory	Prompting for discussion	Studying after the course	Description and prior assessment of prerequisite knowledge
	Positive content feature	Difficulty of exercises	Wishes for means of teaching	Wishes for means of studying	Variability in prerequisite knowledge by topic
	Wish concerning content		Time usage	Benefits of exercises	
	Content problem		Wishes for exercises	Noticing of not understanding	
	Type of exercises		Wishes for teaching speed		
	Amount of exercises				

Major category	*Prior knowledge*	*Reason for attending*	*Dropout reason*	*Home assignments*	*Satisfaction*
Categories	Utilisation of knowledge gained from course			Pre-course material	
	Other reason			After-course material	
				Wishes for home assignments	

The categories called *Content*, *Level of difficulty*, and the newly created *Means of teaching and studying, speed* are all salient features of a *Course*. And the *Level of difficulty* is clearly affected by the existing knowledge of the student, that is *Prerequisites* and *Prior knowledge*. These can in turn be affected by *Pre-course preparation*.

> "They were, I know they were weak, and there were no surprises as such." (*prerequisites*)
>
> "I had already familiarised myself with the subject, the tool was familiar, and I had somewhat studied and worked with it." (*prior knowledge; pre-course preparation*)

The results of the grounded theory method coding after combining the major categories of Table 15 on the preceding page and finding relationships – other than simple part–of relationship – between them are shown in Figure 30.

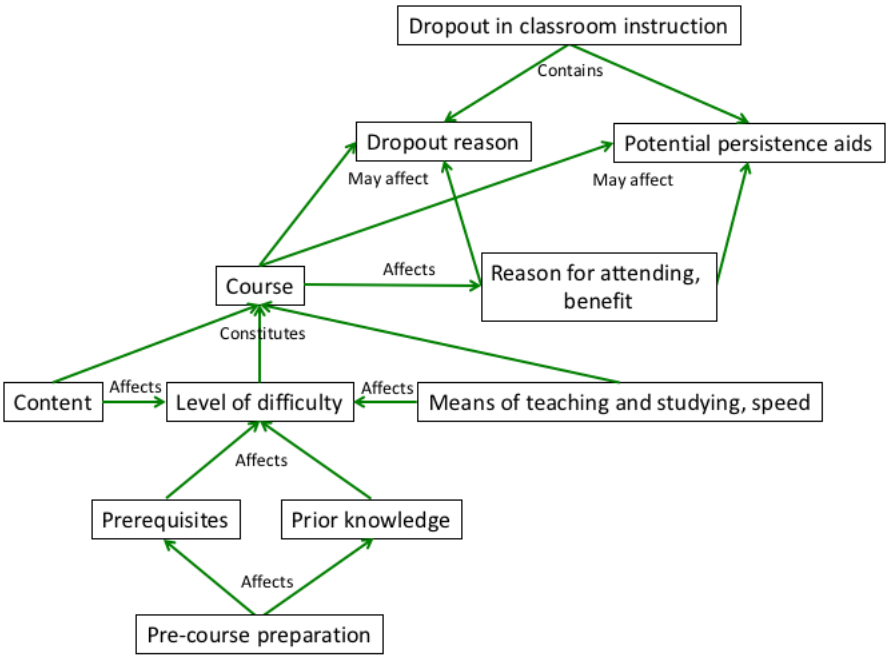

Figure 30: Reasons for dropout in classroom instruction

5.1.7 Contrasting emergent theory with existing theory

5.1.7.1 Matching features As mentioned in section 2.5.3.3 on page 30, Rovai's *Composite persistence model* has an important major category of *Internal factors* that the earlier Tinto's, and Bean and Metzner's models contained only parts thereof. The category maps nicely on the *Prerequisites* and *Prior knowledge* categories of the emergent theory presented here. Furthermore in Rovai's model the *Program fit* category covers the *Content* of the emergent theory, as does the *Pedagogy* category cover the *Means of teaching and studying, speed*.

Next, the following two categories of Rovai's model map rather directly on the *Reason for attending, benefit* category of the emergent theory:

Utility "measures students' perceptions of the usefulness of their college education for employment opportunities (practical value) and personal development" [5, p. 522].

Outside encouragement "friend encouragement, employer encouragement" [5, p. 529], the latter of which is of importance here

5.1.7.2 Mismatches Interestingly enough, all the other models concentrate on the dropout reasons, not on the persistence aids. Given that the interviews in this study were as open as possible around the subject, also the *Persistence aids* rose as a category of their own. On the other hand, as the diagram above shows, very many of the same features can be grounds for either dropout or persistence.

Also as a very interesting observation, all the other models cite goal commitments, defined by [141, p. 115] as "degree to which individuals are committed to the attainment of those goals". This feature, essentially *motivation*, does partially emerge in the interviews conducted in this research in the *Reason for attending, benefit* category, but not as directly and wholly as could be assumed. It is however possible that the small amount of interviewees – lacking those with an involuntary participation – does cause this. Further research is suggested to more thoroughly analyse the participants whose decision to attend on the course has not been voluntary.

5.1.8 Analysis of the interviews in the light of the emergent theory

The essential information related to the research given by Figure 30 on the previous page consists of **dropout reasons**, and **potential persistence aids**. These are extracted from the interviews to Table 16 on the following page (dropout reasons) and Table 17 on the next page (potential persistence aids). In the latter one the most quoted statements have been bolded.

Additionally **how the phenomenon was generally felt** is described in Table 18 on page 96, which shows general feelings or notes of each interview. It is worth observing that satisfaction mentioned in interviews 3, 4 and 6 was not directly asked about in the interview questions, but the interviewees brought the feeling up themselves. Also basically all of the dropout interviewees wished for less speed in either the exercises or on the whole course.

Table 16: Classroom interview results: Dropout reasons

Interview	How did dropout manifest	Reasons for dropout
1	Too little time for the exercises	(not really a dropout; see Table 18 on the next page)
2	(not a dropout)	–
3	Means of teaching difficult to follow due to speed, and did not understand everything	Inadequate prerequisite knowledge
4	Too fast instruction	Inadequate prerequisite knowledge
5	Did not understand	Inadequate prerequisite knowledge
6	Too fast instruction	Inadequate prerequisite knowledge

Table 17: Classroom interview results: Potential persistence aids
(the most quoted statements have been bolded)

Main category	Aids
Content	Less content or longer course
	Good examples and good exercises
	Easy content
	Exercises that support learning
	A practical example of a larger project
	Best practices
	Wish concerning exercises: a larger application, of which only a part is modified
Level of demand	Adequate level of difficulty for the exercises
Teaching style	Teacher was keen to help
	Teacher adjusting the course to suit the current students
	Teacher showing the "big picture"
	Teacher emphasising the essential features of an exercise beforehand
Studying style	Small group work
Prerequisites	**Adequate prerequisites**
	Prerequisites properly described before the course
Prior knowledge	Prior self-study and work
	Worked with a previous version
Home assignments	**Pre-assignment**
Reason for attending, benefit	**Utilisable course content**
Satisfaction	Satisfaction even when not understanding everything

Table 18: Classroom interview results: General notes

Interview	Notes
1	The interviewee did not feel any dropout to be happening, and was satisfied with the learning results
2	Most critical of the course, especially mentioned several times the exercises to be too copy–paste
3	Was satisfied with the parts that were understood. Generally did want to courses to rather be too difficult than too easy.
4	Was satisfied with the parts that were understood. In this case a more basic course (which was in the course offerings of the company) would have been a better fit.
5	Participated in place of another who had left the company, though did want to personally learn about the subject also. An interesting case as had used the language for about 10 years but did find some of the new features of the language used at the course a hindrance to learning. Was ready to peruse the course material after the course rather than expecting everything to be understood or remembered during the course.
6	Was satisfied with the parts that were understood. Was unsure of how each exercise fitted to the course content. Was ready to peruse the course material after the course rather than expecting everything to be understood or remembered during the course.

The interviews show that the generalisation made in the study setup that dropout can be measured just by following exercises is somewhat faulty – it can be lower as especially the interview number 1 shows.

5.1.9 Interview and textual content summary

A major theme of these interviews was that students were generally satisfied with the parts that were understood, in other words learning did happen in spite of inadequate prerequisite knowledge. This is an important aspect when dropout is analysed in the context of short courses – a dichotomous dropout-or-not view is not warranted. Prior course material or a pre-assignment were seen as beneficial, but this was also explicitly asked about, and not everyone agreed that they would use such content.

Otherwise inadequate prerequisite knowledge was by far the most major concrete reason for dropout as seen in these interviews.

Considering motivation in course exercises, non-motivating exercises as a dislike of copy–paste exercises was brought up. This aligns with the information gained from the exercise comments, and with the motivational theory presented in 2.4.3.5 on page 22.

The most apparent wishes concerning the course content – whereas not directly related to dropout – were best practices, and a need for examples of architecture. These are understandable as they are facts that a knowledgeable teacher can provide with relative ease, whereas especially architectural solutions would be demanding to present in for example a book format.

5.2 Results of dropout in e-learning courses

5.2.1 Dropout definition

Defining dropout has already been discussed in the introduction in subsection 1.2.5 on page 3, and in section 2.5 on page 24. Furthermore an important aspect for defining dropout has been raised in introduction subsection "Problems caused by dropout" on page 3, namely that the definition can be affected by the observer who is interested in the said phenomenon. Related to this, in the case of e-learning two main viewpoints can be thought to emerge:

1. Problem from the viewpoint of the course provider. If offering the content for a number n students, it would be beneficial to get as many of them as possible to complete the course, thus making further sales easier. The actual dropout count could be calculated from the whole amount of invited persons n, even if a smaller number m actually log into the e-learning system, a smaller number o use the system for a marked period of time. This is related to *from which numbers the dropout percentage is calculated*.

2. Problem from the viewpoint of the of the student is different. If she already knows the subject, logging on is a waste of time. If she already knows some part or parts of the content, she might be satisfied with using only a brief time for studying. So in this case she would be happy if she would have learned only a small piece of information, if that piece were useful and previously unknown to her. This is related to *how the dropout inside a given course is defined*.

Considering the first aspect, in this study the research question has been set from the viewpoint of the course provider, and so the invited person number n is used for calculating dropout. Additional grounds for using this full number is that the students would participate on a respective classroom course, and so would have need for the information provided by the e-learning content. Moreover, as mentioned earlier, this prerequisite usage of e-learning is one major scenario in the company involved, and in an ideal situation all the classroom participants would at least visit the e-learning course. This is true also for the other case of providing e-learning for profit, where a company pays for an e-learning course for its employees. Again if the course has been paid for for a certain amount of people, the dropout calculation is again natural to calculate against the whole number of invited persons.

Related to the second aspect is the more difficult question of defining dropout inside the course.

Let us quickly recall the limitations in the e-learning course settings in this study. The course was made to be as close a copy of an existing classroom JavaScript course as feasible. The grounds for this were that this would be the most common way of creating e-learning content in the target company to save expensive work hours. On the other hand this basic e-learning type of *Online courseware* was chosen to leave room for studying variations to the platform in the future. This meant that no extra features like an exercise system that would analyse or grade the exercises would be implemented at this stage.

The data given by the system includes time spent at each page in the content, including the page titles so that individual pages could be analysed. This would give us with the following choices for giving a definition for dropout:

1. Total time spent in the content
2. Time spent with exercises[27]
3. Analysis of a certain section of the content having been read through

The e-learning content consisted of 33 content pages, one page for installation instructions, six pages of exercises, and six pages of exercise solutions, altogether 46 pages. If one would quickly peruse through only the content pages, using 30 seconds per page, it would take 17.5 minutes of time. On the other hand, the course content was modelled after a full day course of about six effective hours. Given that the total time spent in the content is heavily affected by the previous knowledge of a given student, using a certain percentage of pages visited to denote dropout would thus not be likely to give a meaningful answer.

In the case of this e-learning system the *amount* of pages viewed could present a more usable way to denote if a participation has been a dropout or not. The exercise and installation instruction pages did not add any content per se, so the percentage of viewed pages could be counted relative to the 33 content pages. However using such a percentage choice would be a random one, and also would be influenced by previous knowledge.

About the time spent in the exercises, the page movement analysis did soon show that very little time was spent there. A probable cause also in this case is that many of the students did know the subjects of the exercises already and did not want to try them out at all. Thus using the exercises to give a figure for dropout would once again be distorted by previous knowledge.

In the case of this JavaScript course the most interesting content section, related to programming custom objects using the language was situated right at the end of the course. It can rather safely be assumed that persistent persons would read through those three pages if they had reached that section, and more knowledgeable persons would quite fast jump to that location. On the other hand if someone is new to the language, and does not have the time and energy to finalise the content, it would correctly count as dropout. So in this case the definition of dropout is whether a person has read through those three final pages.

As a final note to this definition, exhaustive interviews were later used to find more about the subject. Almos all the participants were interviewed so that the definition used here would not arbitrarily cut out some interesting cases.

5.2.2 E-learning course

5.2.2.1 Invitation emails Altogether 147 invitations were sent to possible participants, although only 88 of these were sent when page-by-page movement analysis was in operation in the e-learning platform. Furthermore there was some wording differences in the invitation emails as the first ones did not have a mention of the course content being about the JavaScript language; this is treated below on the next page.

The first email invitation text is shown in Figure 31.

[27] As mentioned in subsection 4.5.2 on page 60, the exercises did have buttons for reporting exercise completion, but unfortunately apart from a few cases these were not used by the students.

***Subject**: jQuery course: Advance material in eLearning format*

Hi and welcome on the jQuery course starting on 13th October!

For voluntary but recommended advance preparation related to the JavaScript language we can utilise an eLearning course, which I have created for my postgraduate studies. Information about the research and description about exercise reporting logic can be found in the following: http://sovelto.s3.amazonaws.com/eLearning-kurssin_datakerayssovellus.pdf

The eLearning course: `http://soveltoel.com/js1309/`

Your personal information is:
Username: `xxxx`
Password: `yyyy`

The eLearning material can be used until the end of the classroom course.

Please contact me if you have any questions about the eLearning environment!

Br, Panu

Figure 31: E-learning invitation email text

5.2.2.2 Invitation timing The invitations for the e-learning course were sent about two weeks before the classroom course. Earlier invitations could not be made due to late registrations as discussed in subsection 4.5.2 on page 60. This invitation timing situation in this research is completely equivalent to the situation in the company also outside of the research, and thus the research setting resembles the real life situation, although the factor was known to be a possible dropout reason uncovered by earlier research [95, p. 104].

Although time shortage was a major reason of dropout according to the interviews, the rather tight schedule was not mentioned in any of them. Thus it can be posited that an earlier notification would not have made a great difference – as also learning has to happen so close to the course that forgetting the contents does not start to emerge.

5.2.2.3 Invitation counts and login rates Altogether 88 invitations were sent when page-by-page movement analysis in the e-learning content was in place, and 31 students of these logged on to the system. The exact description of the invitations, their counts, textual variations, and variations in the e-learning system is described in G on page 158.

Time usage of the 31 participants who logged in when the page-by-page movement analysis was in place on the server is listed in Table 19 on the following page, ordered by total time from largest to smallest.

Table 19: E-learning system time usage

Time	Pages	NoEx	OO	Username	Classroom course(s)	Interviewed
7:58	33	20		pwkhrenz	20480 Programming in HTML5 with JavaScript and CSS3	
7:45	46	33	×	ydahwtfd	HTML5 and CSS3 for software developers (open source)	yes
4:35	39	26	×	qfjkqwhi	20480 Programming in HTML5 with JavaScript and CSS3	yes
4:25	40	31	×	ddpqzqpx	AngularJS	yes
2:57	17	11		vmandixi	Modern web site with jQuery	yes
2:25	45	33	×	eijcfvez	AngularJS	
2:14	33	25		zshjaqae	AngularJS	
2:08	35	31		tkuvgxyc	HTML5 and CSS3 for software developers; AngularJS	
2:00	44	32	×	vkjgsufn	AngularJS	yes
1:55	38	32	×	hqakmpyc	HTML5 and CSS3 for software developers; AngularJS	yes
1:52	40	31	×	ceigscbh	HTML5 and CSS3 for software developers; AngularJS	yes
1:41	43	30	×	kaeurxfb	HTML5 and CSS3 for software developers; AngularJS	yes
1:18	31	27	×	dbhntkak	20480 Programming in HTML5 with JavaScript and CSS3	yes
1:15	41	33	×	fhjbmgut	AngularJS	yes
1:01	40	31	×	ggjvsexe	HTML5 and CSS3 for software developers; AngularJS	yes
1:00	18	13		bhaakftr	AngularJS	
0:57	33	25		tgvbqkun	AngularJS	
0:40	36	33	×	udchyzpw	HTML5 and CSS3 for software developers; AngularJS	
0:37	42	30	×	vcvvhbyn	AngularJS	yes
0:32	46	33	×	erjrzcmz	AngularJS	yes
0:29	36	30	×	shkhpemu	HTML5 and CSS3 for software developers; AngularJS	yes
0:28	10	8		zhurdkdh	HTML5 and CSS3 for software developers; AngularJS	yes
0:18	22	21	×	wwyjkcvt	HTML5 and CSS3 for software developers (open source)	yes
0:15	29	29	×	dsbacadq	20480 Programming in HTML5 with JavaScript and CSS3	yes
0:14	6	6	×	awpdnhvd	AngularJS	
0:12	5	4		tgvrqhbz	20480 Programming in HTML5 with JavaScript and CSS3	yes
0:06	9	2		ekzkjshm	AngularJS	yes
0:03	6	5		wgxigwfw	HTML5 and CSS3 for software developers (open source)	
0:02	6	5		igxeiybi	Modern web site with jQuery	
0:01	2	2		gcxzhvpr	20480 Programming in HTML5 with JavaScript and CSS3	
0:00	2	2		qfatiham	HTML5 and CSS3 for software developers; AngularJS	

NoEx = count of content pages without exercises
OO = has gone through all the three pages concerning programming custom objects in JavaScript

5.2.3 Quantitative analysis of e-learning reporting: Prior and prerequisite knowledge

As a special note, unfortunately prior and prerequisite knowledge were asked only for the 22 last logged on participants.

Considering time usage, prerequisite knowledge, and prior knowledge, the first one is mapped against the others in Figure 32 on the next page and Figure 33 on the following page, respectively. The fact of no correlation is evident when looking at these graphical presentations. Also, Spearman's ρ_S between time usage and prerequisite knowledge is $\rho_S = -.026$, $p = .910$. Between time usage and prior knowledge the values are $\rho_S = .091$, $p = .686$.

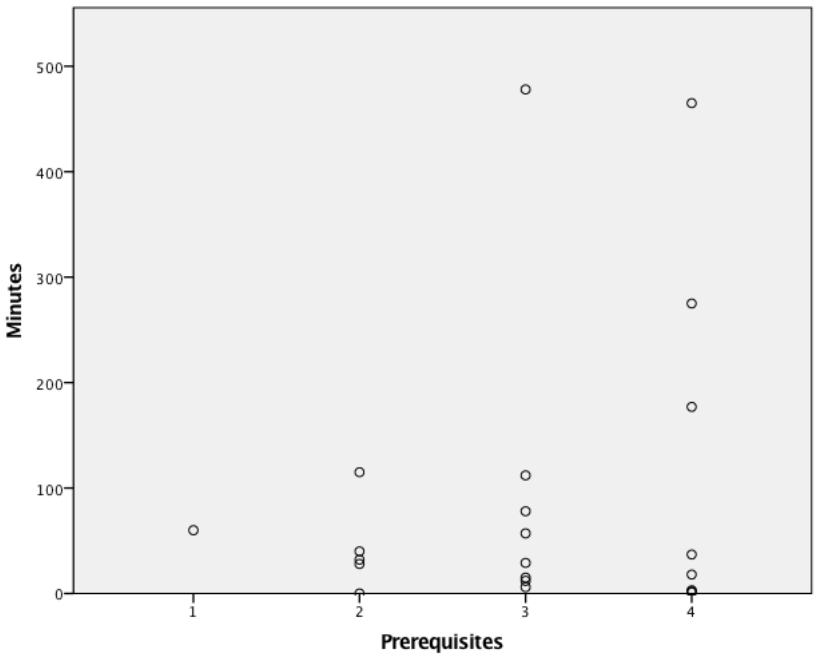

Figure 32: E-learning prerequisites and minutes spent
Horizontal scale: 1 = *insufficient knowledge ...* 4 = *excellent knowledge; see page 76*

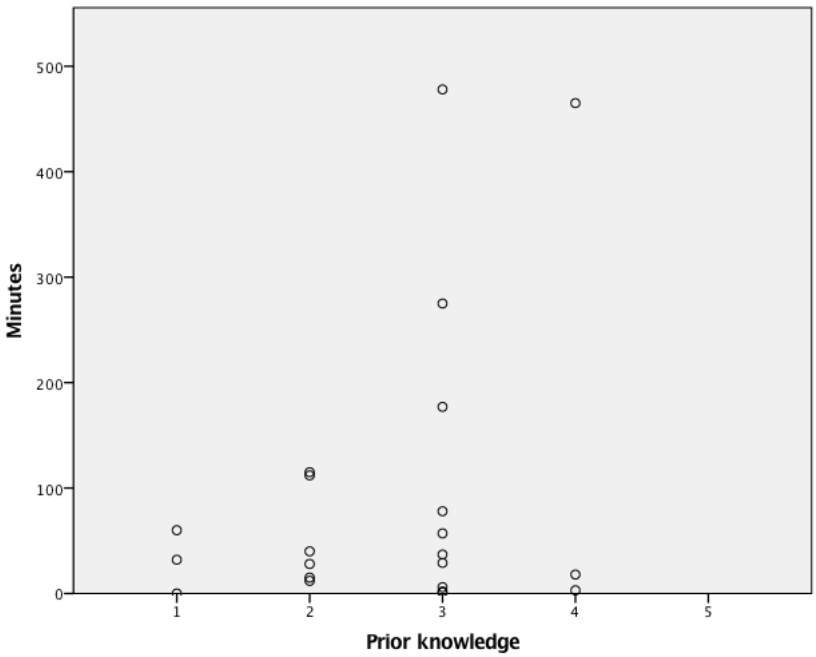

Figure 33: E-learning prior knowledge and minutes spent
Horizontal scale: 1 = *no knowledge ...* 5 = *strong knowledge; see page 78*

The same analysis regarding dropout as defined in subsection 5.2.1 on page 97 is shown in Figure 34 and Figure 35 on the next page. In these Figures dropout is depicted by the number zero on the vertical axis. In this case, Spearman's ρ_S between dropout and prerequisite knowledge is $\rho_S = .023$, $p = .920$. Between dropout and prior knowledge the values are the same, $\rho_S = .023$, $p = .920$.

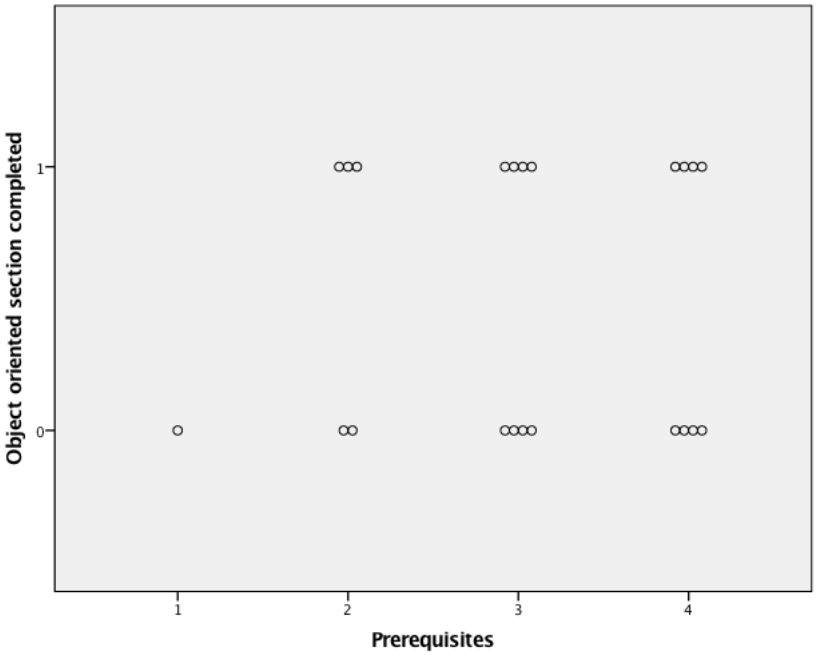

Figure 34: E-learning prerequisites and dropout
Horizontal scale: 1 = *insufficient knowledge* ... 4 = *excellent knowledge; see page 76*
Vertical scale: 0 = *not completed,* 1 = *completed*

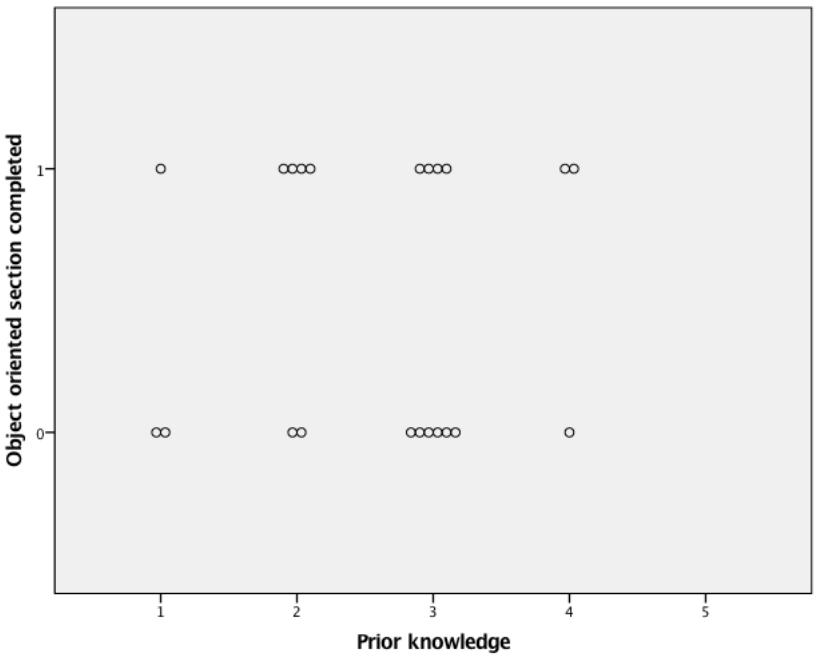

Figure 35: E-learning prior knowledge and dropout
Horizontal scale: 1 = *no knowledge ...* 5 = *strong knowledge; see page 78*
Vertical scale: 0 = *not completed,* 1 = *completed*

When analysing the graphical depictions of dropout, it is interesting – and standing to reason – that no persons with inadequate prerequisite knowledge did complete the e-learning course.

5.2.3.1 Summary: Dropout percentage In all 88 students had received an invitation to the e-learning course when the page-by-page movement analysis was in effect, and 31 of these logged into the system.

Of these 88 students, 18 did read the whole final section about custom object creation in JavaScript. And in fact if time usage is examined, 17 students did spend forty-five minutes or more in the system – a figure very close to the previous one.

Using the final section reader count giving a number of dropouts as $88-18 = 70$, the dropout percentage in e-learning $d_e = 80\%$, 95% CI $[72\%, 88\%]$. This is in alignment with the figures presented in the introduction.

5.2.4 Qualitative analysis of e-learning reporting

Unfortunately almost all of the participants had understood the reporting software questions to be related to the upcoming classroom course and thus no formal analysis can be made. The three participants that had understood the questions as relating to the e-learning version all reported to be interested in the basic information that the e-learning course was all about – so probably nothing very major could have been gotten from the other responses anyway.

Considering the exercise-specific comments, only one participant had given one comment and thus there is nothing to analyse.

5.2.5 E-learning interview results

5.2.5.1 Interview participants This time finding interviewees was easier than in the classroom section as:

- any student could be interviewed;
- very many of those who were logged on could be classified as dropouts;
- over a half of possible students agreed to be interviewed.

Of the 27 persons with over five minutes of time usage 19 were eventually interviewed. Four of the students refused the interview and four could not be reached even after multiple attempts via phone and email. The five minute limit was chosen as below it the student could have no real experience of the e-learning system; the times below five minutes were 0:03, 0:02, 0:01, and 0:00.

The average duration of interviews was 17.5 minutes, with a standard deviation of 6.3 minutes.

5.2.5.2 Analysis The interviews were transcribed and then analysed using GTM as depicted earlier in Figure 29 on page 90.

An example of the *open coding* phase of GTM is given in Table 20 on the next page.

Table 20: E-learning interview GTM example: Open coding

Excerpt from text	Open code
Well, there should be like, or, then some small scale test or something else. Somehow, or that you yourself know that at what level you, like, are or what did understand or not, that would first spring to mind. (e-learning transcription 21)	Motivation
They likely go so that first a piece of theory and then exercises afterwards, like that might be the traditional way. (e-learning transcription 6)	Course structure
Well, then that probably, if you take into account that they are always interrupted, that from there it is easy to then continue at some point. (e-learning transcription 6)	System enhancement idea
It was likely such, that when from there a link was sent, that there would be good background information that should be known about JavaScript, so I have fairly little played with it, so I thought that it would probably be beneficial to check (e-learning transcription 9)	Reason for attending
But, yes, well probably that, this attending a course is not the core business, that naturally affects that. For that reason I used the two hours that I did, not five hours, because, like it is only a side matter. (e-learning transcription 18)	Dropout reason
Probably further exercises, because that did well stay in the basics. (e-learning transcription 23)	Content enhancement idea

Finding synonyms An example about finding synonyms is shown in the following list:

- Attendance reason; synonym: reason for attending
- Good feature of content; synonyms: good in structure, good aspect of content, positive feature of content
- Time division; synonyms: time division in content, content time usage
- Material structure problem; synonym: content problem
- Challenge of e-learning; synonym: difficult feature of e-learning

Selective coding Results of the selective coding phases are shown in Table 21 on the following page.

5.2.6 Emergent theory from the interviews

The *Whole e-learning system* can be divided to two distinct parts: to the *Platform*, which does not vary from course to course, and to the *Content* that is

Table 21: E-learning interview GTM: Selective codes

Major category	*Dropout reason*	*Persistence reason*	*External factor*	*Content*
Categories		Motivating reason	Reason for attending	Content improvement idea
		Problem caused by dropout	Previous subject knowledge	Positive content feature
			Time usage reason	Time usage of content
			Time usage at work	Learning style
			Interrupting factor	Difficulty level
				Structure of material
				Extent of material
				Content problem
				Content presentation

Major category	*E-learning platform*	*The whole e-learning system*	*Feature of e-learning*	*Learner's learning control*
Categories	Positive platform feature	Content/platform improvement idea	Strength of e-learning	Time usage of learner
	Platform improvement idea	Quality appraisal	Challenge of e-learning	Manner of going through the course
	User interface bug		Feature that advances e-learning	Disruption mitigation
	Usability			
	Advance information			

associated with a specific course. These three categories did very clearly rise from the open codes during the selective coding phase.

Initially *Motivating reason* was a major category, but with more thorough thought it seems clearly to be part of *Persistence reason*. Also *Problems caused by dropout* can be seen as a reason for persistence.

Initial situation, containing *Reason for attending* and *Previous subject knowledge*, cannot be altered and thus were moved into the *External factor* category.

The theoretical memo graph – emergent theory – shown in Figure 36 created from previous observations contains two major categories for dropout (or persistence): *Features of e-learning* including the platform and course content, and *External factors*.

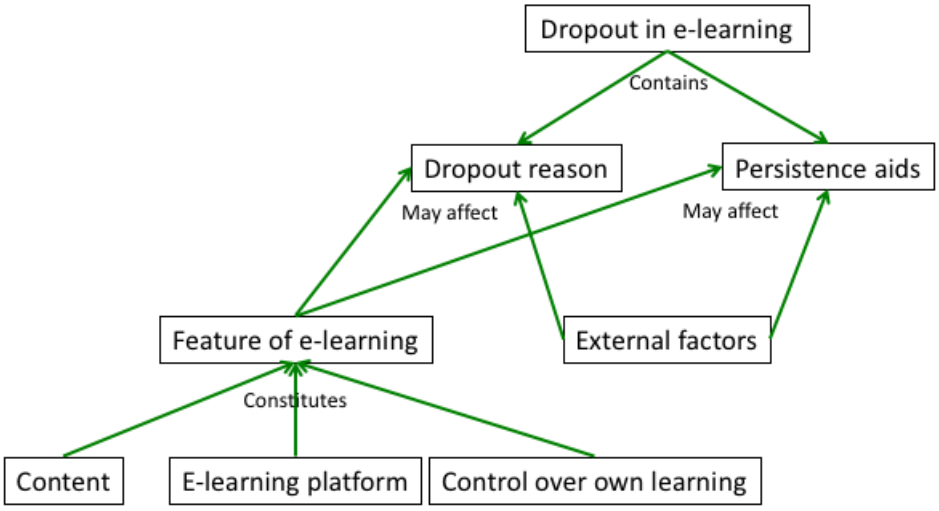

Figure 36: Dropout in e-learning

5.2.7 Contrasting emergent theory with existing theory

5.2.7.1 Matching features To aid in the comparison with existing theory, Park's *Theoretical framework for adult dropout in online learning* has been copied as Figure 37 on the following page from subsection 2.6.2.1 on page 33 where it was originally presented.

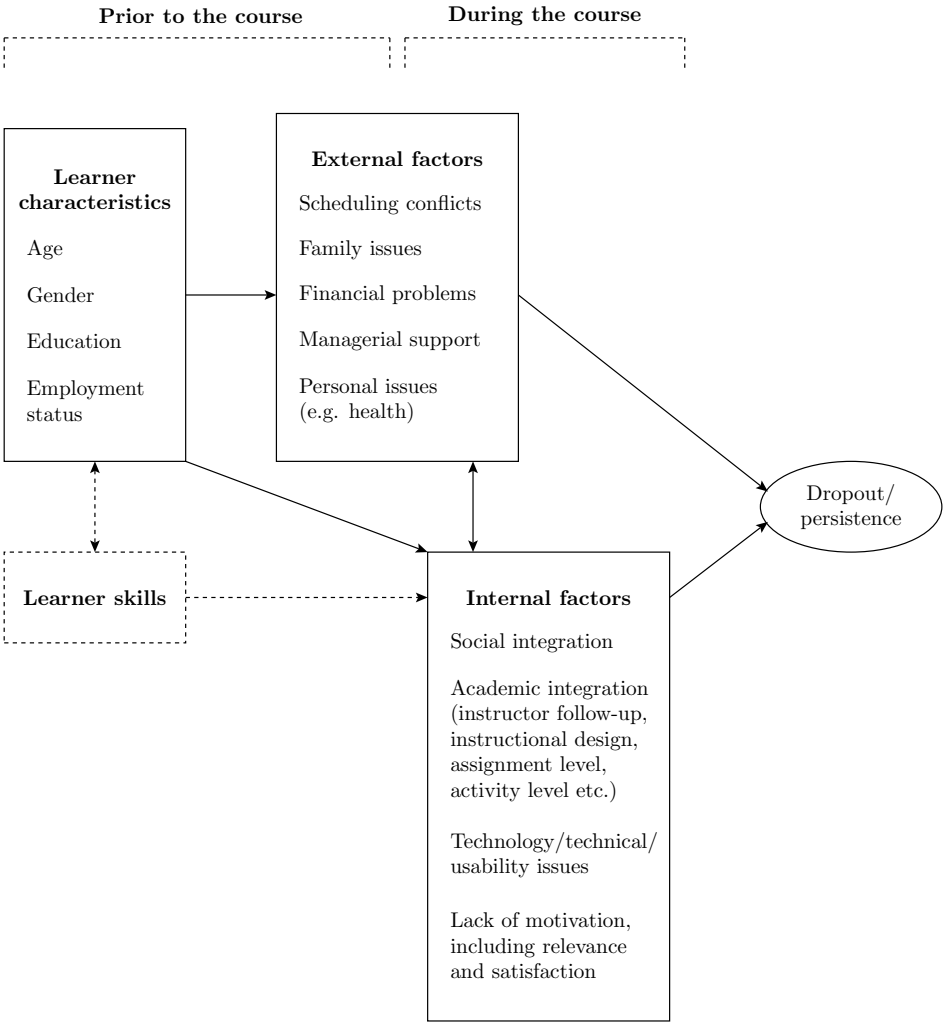

Figure 37: Park's *Theoretical framework for adult dropout in online learning* (borrowed from [108, p. 255]; clarified "Lack of motivation" to include relevance and satisfaction)

When contrasting the findings with Park's framework the grouping can be found to be almost eerily similar. The *External factors* category even has the same name in both. Park's *Internal factors* category maps directly to the *Feature of e-learning* category – this may not be evident when the names of the categories are compared, but the subcategories are similar in content.

In this research Park's *Learner characteristics* and *Learner skills* categories did not emerge. Regarding the former, this is in agreement with Park's findings that "learners' age, gender, and educational level did not have a significant and direct effect on the dropout decision" [109, p. 215]. And similarly the latter agrees with the notion of "learner skills are in a grey box because these have found little empirical support in previous studies" [109, p. 208].

5.2.7.2 Mismatches Again, as in subsection 5.1.7.2 on page 94 regarding dropout in classroom environments, Park's model concentrates on the dropout reasons, not on the persistence aids. But also again as the diagram above depicts, many of the same features can be grounds for either dropout or persistence.

Park's model does have a good point about adding a further aspect: whether or not a certain feature affects a decision prior or during the course. In the case of this research the time between informing about the e-learning course and the classroom course that the e-learning course is related to is relatively brief. Thus there is most likely very little that can be done prior to the course to affect the persistence decisions, and the factor was did not emerge from the interview analysis.

5.2.8 Analysis of the interviews in the light of the emergent theory

The essential information related to the research given by Figure 36 on page 107 consists of **dropout reasons**, and **persistence aids**. These are extracted from the interviews to Table 22 (dropout reasons) and Table 17 on page 95 (persistence aids)[28]. The bolded features were factors that can be affected on by altering either the course content or the e-learning platform, and these served as the basis on which the web-based survey presented in section 4.5.4 on page 66 was grounded. Thus the survey represents the *essential factors that can be affected on by altering either the course content or the e-learning platform.* As a special note reasons for dropout were not asked again in the web-based survey as there was enough information gained via the extensive interviews. Omitting these also helped in keeping the survey as short as possible in order to avoid losing respondents.

Table 22: E-learning interview results: Dropout reasons

Reasons for dropout	**Number of mentions**
No time for learning	12
The subject of the course not directly related to work	2
Forgetting	2
Reserved only a certain amount of time	2

[28]The other categories of Table 21 on page 106 are not broken down here to conserve space.

Table 23: Classroom interview results: Potential persistence aids
(the bolded features are factors that can be affected on by altering either the course content or the e-learning platform)

Category	**Aids**	**Number of mentions**
Motivation	Compulsory	2
	Certificate	4
	Admission to a followup course	1
	Competition	3
	Creation of a complete application in the exercises	2
	Progress monitoring	13
	Growable points	1
	Course history	1
	Gamification	3
	Comparison with other participants	2
	Practical and good platform	1
	Information about concurrent students	1
	The content itself	1
	Completion marking only from a finished course	1
	Dedicated time from work	5
	The subject of the course is the main work of the student	1
	The only way of studying the subject	1
	Reward (on a coffee ticket – money range)	4
	Reward for e.g. the first three or the first 10%	1
	Story-like content	1
	Exciting content	1
	Interesting exercises	1
	Pleasant user interface	1
	Final examination	4
	Exercise after each section, which is needed to continue	1
	Section-specific deadlines	1
	Lowering of the price of a follow-up course	1
	Final feedback about success	1
	Possibility of completing one module at a time	1
Problem created by dropout	Important features remain not learned	1

5.2.9 E-learning survey results

The web-based survey depicted in section 4.5.4 on page 66 was sent to 31 persons mentioned in 19. Eventually 19 of these answered the survey. One had filled in only the first question and this result was not analysed, leaving 18 complete results. 15 of these had also been interviewed, meaning that four of the interviewees did not answer. Two of these had changed workplaces and could no longer be reached, two just did not answer even after two reminder emails. The possible effect of these no-answerers is analysed in subsection 5.2.9.2 on page 119.

The results are shown graphical format in Figure 38 and Figure 39 on the next page. The first one shows the variations between answer more clearly, and the second one makes it easy to compare averages between factors. The titles in the figure are somewhat abbreviated and the full questions from subsection 4.5.4 on page 66 are rewritten in Table 24 on page 113.

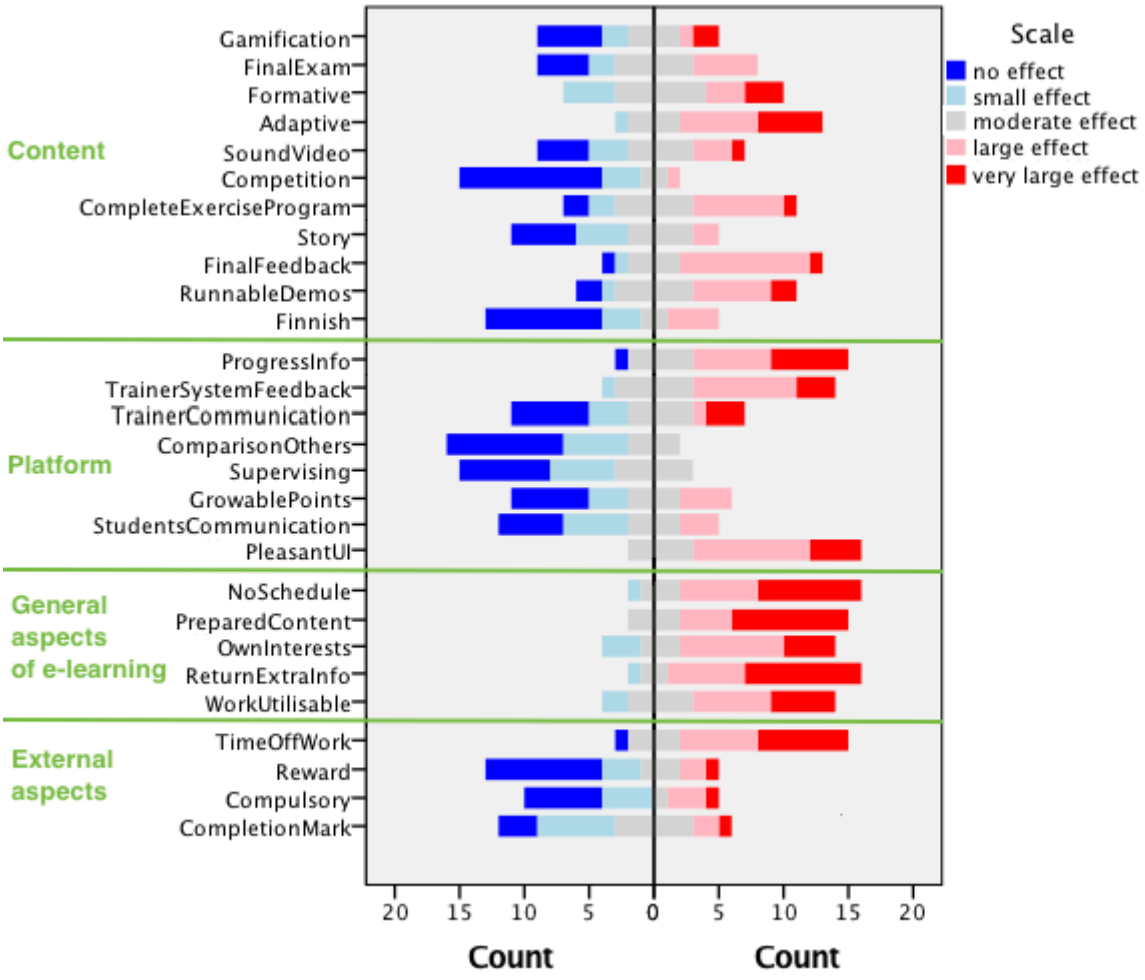

Figure 38: Features that possibly raise the motivation to complete e-learning courses

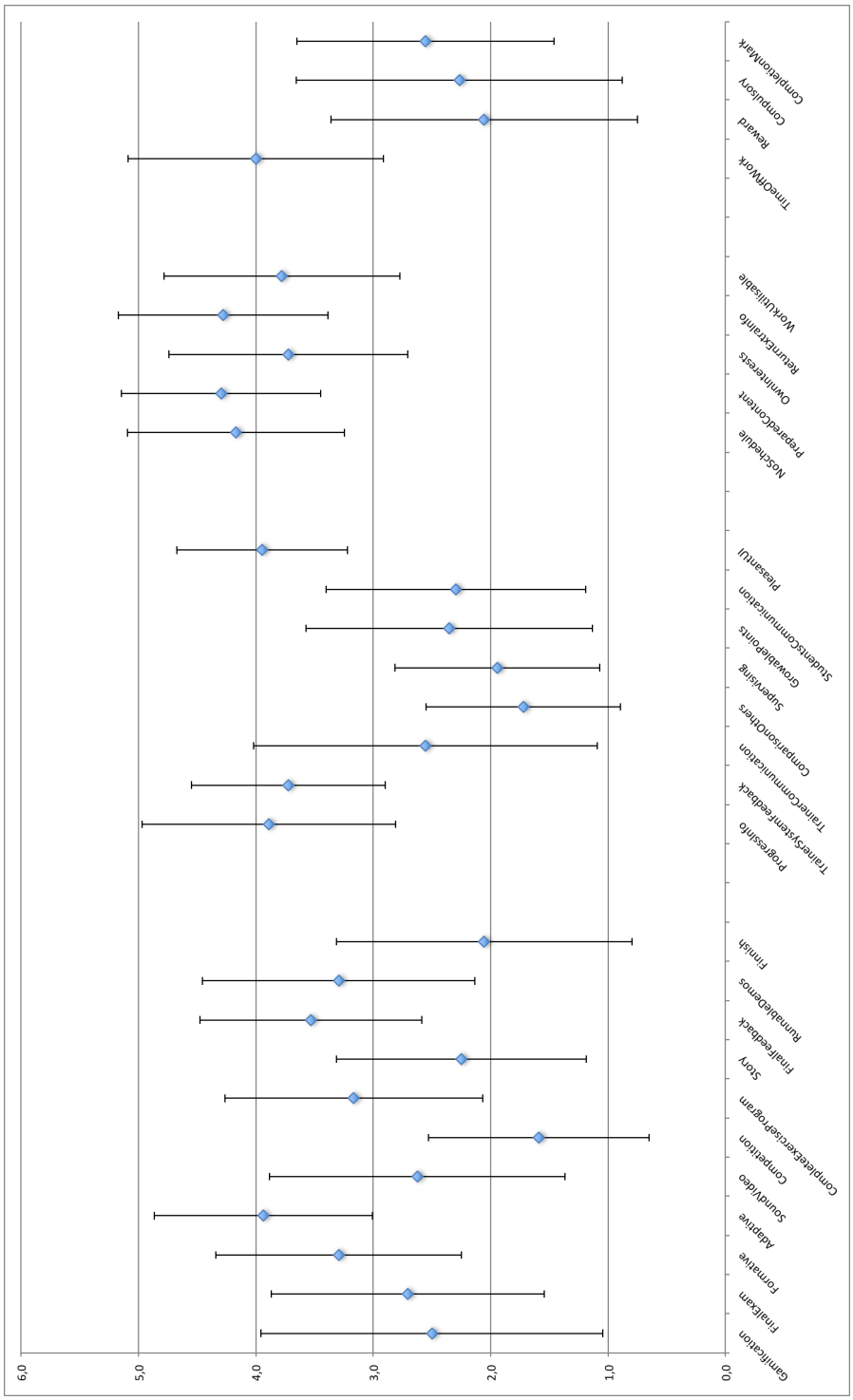

Figure 39: Averages of the features that possibly raise the motivation to complete e-learning courses

Table 24: Figures 38 and 39: Titles expanded

Category	Abbreviation	Full question
E-learning course content	Gamification	Gamification
	FinalExam	Final examination and a certificate after it
	Formative	Small tests inside the content that help assess own level
	Adaptive	Content and/or exercises that adapt to own capability
	SoundVideo	Voice and/or video content
	Competition	Competition with other participants
	CompleteExerciseProgram	Completing a whole application during the exercises
	Story	Story-like content
	FinalFeedback	Final feedback about success
	RunnableDemos	Demonstrations, which can be run phase by phase
	Finnish	Finnish language content
The e-learning platform	ProgressInfo	Progress information (e.g. time used or remaining content)
	TrainerSystemFeedback	Feedback about the achievements (from the teacher or the system)
	TrainerCommunication	Communication possibility with the teacher
	ComparisonOthers	Comparison with other participants
	Supervising	Progress monitoring (the teacher monitors)
	GrowablePoints	Growable points or other small awards
	StudentsCommunication	Communication possibility with other students (chat and/or discussion board)
	PleasantUI	A pleasant user interface
General advantages of e-learning	NoSchedule	Participation is not timed
	PreparedContent	Prepared content (vs. googling)
	OwnInterests	One can choose on which subjects to concentrate
	ReturnExtraInfo	One can return to certain subjects, and can search for additional information
	WorkUtilisable	The content can straightforwardly be applied at work assignments
External aspects affecting motivation	TimeOffWork	Dedicated time from work
	Reward	Reward (e.g. coffee ticket, money, or something else)
	Compulsory	Compulsion
	CompletionMark	Completion mark only of a completely finished course

5.2.9.1 E-learning survey result analysis The results are interesting as they for example show that in this context – adult software professional education using short-duration courses – posit the general advantages of e-learning clearly as the most important category. The results are further broken down category by category in the following paragraphs.

E-learning course content

Most helpful factors One factor distinguishes itself as clearly the most influential one, namely *adaptive content*. This is understandable, as in all learning – be it via a book, in a classroom, or otherwise – finding the correct level of difficulty for a given student has always been imperative. Too easy content causes boredom, skipping content possibly missing some important pieces, and easily leads to dropout. On the other hand, too difficult content may lead to even faster dropout if the content is mostly unintelligible for the student.

Other four which are above average are *small tests that help assess own capability*[29]*, completing a whole application during the exercises*, *final feedback*, and *runnable demos*. All of them have about the same amount of answers citing a very large or large effect.

Small tests that help assess own capability can be understood to be an effective way of assessing own capability and to really give the learner a possibility of revising her learning if needed. It is also a facet that can differentiate e-learning from classroom instruction, as adding such tests to classroom would be difficult – requiring a separate application, as would be adjusting the instruction to each learner's learning situation. On the other hand, constructing such tests would in some programming situations be very demanding for the teacher. Small and testable programming assignments are easy enough to create and run when a language's basic features or core libraries are being taught. Server-side programming techniques however often require precise and multi-step installations, and creating and updating a testing environment for such can be a formidable task.

Completing a whole application during the exercises is a feature rather unique to programming instruction that has a possibility of tremendously helping in understanding instruction by creating a realistic and memorable context for a given piece of information. On the other hand, it is not without problems as

- understanding the application and its architecture creates load for the student;
- creating a relevant, real life utilisable, but simple application that utilises a complete enough set of current techniques is demanding for the teacher; and
- moreover the exercises should be created as such that they are not dependent on each other – otherwise it is almost certain that a student gets stuck at some point.

There are technical solutions that assist in creating and organising such exercises, for example using the Git version control for each single exercise by

[29] Commonly called *formative tests* [101, p. 24]

storing its initial and completed versions. Creating and maintaining such a set of exercises is understandably very time-consuming.

Final feedback is an elusive aspect – it was only cited in one interview, and the benefit of such information is not as readily seen as of the other points mentioned in this factor category. It is possible that the survey respondents considered this aspect in its relation to the question six steps above it, namely *small tests that help assess own capability*. Together the small formative tests and final feedback would serve the student well in assessing capability and possible needs for revision.

Runnable demos are a feature that was found to be a major difference between classroom and e-learning instruction in subsection 3.1.1 starting from page 37 where Laurillard's Conversational framework was utilised. As such the demonstrations would be a very interesting feature to be studied in further research, especially given that computing education research as a field has provided multiple studies about visualising features related to programming [35].

Least helpful factors In this category more interesting are the features that are not seen as helpful. The most prominent is *competition with other students*. This is understandable given that the participants are adults that have limited time slots for attending the course, and also are most likely motivated by the course content itself.

Story-like content – having a business case for the content – is the second feature not highly appraised. This can be understood via the fact that software development consists of skills that need to be understood in a general setting, and a certain context for the content may hinder knowledge transfer to other use cases.

Content in the mother tongue, Finnish, was not valued high. Software professionals generally use English on a daily basis and thus this result is not surprising. It is worth noticing however, that four participants did mark this having a large positive effect, thus the factor has more variation than the previous two.

Finally, in this context the *gamification* factor that has been prominently shown as one of unique features of e-learning, is not something that participants as a general rule find important for their learning – only three students accounted it to have a large or very large positive effect. On the other hand, it may be that the participants had difficulty in understanding what gamification in software professional training concretely means, as the question had the largest number of non-answers of the whole survey (four out of 18 did not answer at all).

Other factors A *final examination*, and *sound and video content* were two factors that gathered varying responses, both somewhat below the average.

A *final, summative examination* can be contrasted with *small tests that help assess own capability* – formative examinations – that had been seen as beneficial. As far as learning is considered this is coherent: small tests lead to noticing gaps in own knowledge early on, when returning to the content in question is easy enough. On the other hand, if a summative examination shows major shortcomings in capability, returning to correct content is either more difficult or even leads to dropout if the task is seen as too demanding.

Sound and video content had responses that varied a lot. Some did see it as very helpful, some more as not helpful at all. There are two likely explanations

as stemming from the original interviews. On the other hand, some people really dislike learning by reading and have a strong preference in audiovisual content in their learning endeavours. And on the other hand, in the context of software development learning, a video is a difficult medium for the learner as nothing can be copied to own programming editor for trying on her own. Also finding a certain piece of content after a lecture may be troublesome depending on the features of the video platform.

E-learning course content in other studies Unfortunately the contents of the courses have not been a focus in the adult education related studies found in the literature review. *Satisfaction* has been mentioned in some of them [109, 37], but it is difficult to match with the categories found here.

A single mention of using problem-based learning was found, hinting to the same direction as *completing a whole application during the exercises* mentioned above [7].

The e-learning platform

Most helpful factors A *pleasant user interface* and *information about progress* were the most important features in this category. The first is in agreement with the comments received in the interviews relating to a detrimental effect of user interface problems to the learning experience. The second one supports findings about screen reading vs. reading on paper, where the location information is self-evident in the traditional paper format [82, p. 66].

One more factor did also get high appraisals, namely *feedback given by the system or the teacher about the achievements*. This can be thought to have similar reasoning behind it as formative tests in the previous category that help in assessing possible points that need reviewing by the student.

Least helpful factors Clearly the factor that gained less support was *comparison with others*. This goes to show that not only the stronger version of comparison of the previous category – competition – was disliked, but all kind of comparison does seem to gather scant support.

Progress monitoring done by the teacher was seen almost as ineffectual as comparison with others. The finding is somewhat surprising, as it could be assumed that possible reminders or similar done by the teacher might have been felt as beneficial, but then again the student group consists of individuals that regularly have tight schedules at work and reminders would only be felt as distractions.

Growable points or other small rewards is a facet that in a way combines an elementary form of gamification and very small incentives, and is often found in e-learning systems. Although the average number that it received was low, four participants listed it as a feature that would have a large effect on their learning. So, implementing such a feature would need careful planning, so as to serve the ones that like it and not to do others a disservice.

Finally and surprisingly, a *communication possibility with other students* did fall to the least helpful factor category. The reasons for this would need more thorough research as the interviews did not especially hint to any specifically emphasised need for studying alone, which this finding suggests. It may however be possible that the students are used to spending relatively small amounts of

time every now and then for the study, and there would be no real possibility for meaningful conversations.

Other factors A *communication possibility with the teacher* has more division between "no effect" and "very large effect" answers than any other answer in the e-learning platform category. Due to the large amount of the "very large effect" answers it remains a feature that is rather high on the list of suggested implementations when an e-learning system is being designed for a target group similar to the one of this research.

E-learning course platform in other studies Other studies have been in disagreement with this one in the importance on social features, as they have been found to be an major predictor of persistence [7, 37, 98, 92]. As mentioned above, the fact warrants further research.

Technical difficulties have been mentioned as a source for dropout [121, 129] – this was not asked about directly, but can be counted to align with the need for a *pleasant user interface* found in this study. The same category aligns with another hindrance found, namely cognitive overload [143].

General advantages of e-learning

In the case of *general advantages of e-learning*, all the features that were asked about in the survey did count as very helpful, and the three most helpful features of the whole study[30] were found in this category. This was initially felt as rather unexpected given the relatively high percentage of dropouts in the e-learning system usage part of the study. On the other hand, the alternatives that are classroom education, book reading, or using various snippets found in online resources, suffer from many drawbacks that can be directly contrasted with the features of this category. For example classroom courses are strictly tied to a certain *schedule*, and one cannot choose the *subjects on which the teaching is concentrated*. Books are only sometimes presented in a format that is similar to a course having exercise content, and even more rarely are targeted at software professionals having a similar problem set at work, reducing *applicability at work*. Moreover, *searching for extra information* does need additional effort when using a book. And finally, using arbitrary online content does not represent *prepared content* in any way.

In summary, the answers in this category show that e-learning is a most influential part of contemporary further education, and thus support the need for this study to be made.

General advantages of e-learning in other studies Other studies of dropout in adult e-learning have found especially "relevance" a major reason for persistence [83, 109, 92]. This is in complete agreement with the findings of this study, matching the category named *applicability at work*.

Otherwise the general advantages have not necessarily been spelled out, but have been found an important factor in engaging in e-learning [92].

[30] When analysed using calculating a mean from the answers for each question.

External aspects affecting motivation

Most helpful factors In this category only one factor can be counted to be very helpful, the self-evident *dedicated studying time from work*. The effect was so strong compared to the other aspects of this category that the most surprising find is that one student assessed it to have no effect at all.

Least helpful factors *Rewards* were the feature that was felt to be least important in this category, and to be on par with the four other least inspiring features of the whole study[31], namely competition/comparison, supervising, and Finnish language. In a way this is unfortunate for the designer of an e-learning course as she or he has no easy way of raising the motivation of the students, but naturally the answers are understandable given that the subject of the e-learning course was part of the occupation of the students and thus motivation should mostly be intrinsic.

The course being *compulsory*[32] was slightly more motivating than rewards, and had more variation in the answers. The question also had the second largest number of non-answers of the survey, as three out of 18 did not answer, hinting that this is a difficult feature to have an opinion about.

Finally, *getting a completion mark* had a markedly large variation in the answers. The feature was mentioned several times during the interviews and thus has a definite meaning for some participants. On the other hand over the half of the respondents did feel it to have no or only a small effect. So it may be that there is personal variation in studying for knowledge, studying for a certificate, or possibly studying for both. It is also viable that some employees emphasise completion marks as they form a non-disputable way of showing expertise, and can be possibly used in communication with customers[33].

External aspects in other studies Other studies of dropout in adult e-learning have found especially dedicated study time a very noteworthy factor in helping students to persist [121, 37, 98]. This finding is not surprising and was directly found in this study also. In some studies this fact has been presented in the larger context of organisational support [83, 109].

Also rewards, such as a completion certificate, praise, and promotion have been mentioned [109].

Other notes

After having analysed the survey results, the scaling was found to possibly have benefited from two more scales measuring *hindrance*. In the survey of this research the scale varied from no effect to very large effect, but it is possible that some students would have found certain features even being detrimental to their learning. On the other hand, the survey did contain comment fields for each category and no comments were given, and thus it is likely that no strong contradicting arguments were missed.

[31] Again when analysed using calculating means.

[32] I.e. having been set as compulsory by the employer of the student

[33] Some software projects require that the customer accepts all the individual software developers by analysing their *curricula vitae*.

Summary

Most advantageous factors Considering the *General advantages of e-learning*, all the features that were asked about in the survey did count as very helpful. The factors were, in the order of importance:

- Prepared content (vs. googling)
- One can return to certain subjects, and can search for additional information
- Participation is not timed
- The content can straightforwardly be applied at work assignments
- One can choose on which subjects to concentrate

The findings corroborate the influence of e-learning as a part of contemporary further education.

A *pleasant user interface* and *information about progress* were the most important features in the *E-learning platform category*. One other highly valued factor was *feedback given by the system or the teacher about the achievements*.

In the *E-learning course content* category the most influential factor was *adaptive content*. This is in agreement with the various theories analysed in subsection 3, especially concerning intrinsic load (page 40), expertise reversal effect (page 41), and engendering competence (page 44). Other four noteworthy features are *final feedback*, *formative tests, runnable demos,* and *completing a whole application during the exercises*.

In the *External aspects* category only one factor arose as very helpful, the self-evident *dedicated studying time from work*.

Least helpful factors In the *E-learning platform* category the factor that gained the least amount of support was *comparison with others*. Almost as ineffectual was *progress monitoring done by the teacher*.

Considering the *E-learning course content* category, the least wished for feature is *competition with other students*. This agrees with the previous category; all kind of comparison has scant support.

In the *External aspects* category *rewards* were the feature that was felt to be least important.

5.2.9.2 Missing interview participants Information about the four interviewees that did not answer the survey have been tabulated in Table 25.

Table 25: Missing survey participants that had been interviewed

Time	Classroom course(s)	Prior knowledge	Prerequisites
1:55	HTML5 and CSS3 for software developers; AngularJS	2	2
1:41	HTML5 and CSS3 for software developers; AngularJS	(*)	(*)
0:32	AngularJS	1	2
0:06	AngularJS	3	3

(*)	The information was not asked at the time of the e-learning course or interview

As the table shows there was variation between the participants; this was also checked by reading the interviews. This variation means that no significant bias to the survey results should be caused by these four participants; also they represent only a minority of 21% (4/19) of the interviewees.

6 Summary and discussion

6.1 The research question

The main research question was **how much dropout does happen related to short e-learning courses in the field of professional software development, and what are the main reasons**.

The main question was split into two subquestions:

RQ 1: What is the dropout in classroom-based courses? What are the main reasons for dropout?

RQ 2: What is the dropout in e-learning courses? What are the main reasons for dropout?

6.2 Answering the research questions

6.2.1 Comparing classroom and e-learning format in short courses

In this section the two forms of instruction, related to the short commercial course format in computing education were compared using three theories.

Firstly, the most noticeable differences according to the *Conversational framework* are in the iterations of either of the teacher communication cycle, the internal learning cycle, or in the demonstrations (or lack thereof). So if the material and the exercises are similar, the first major difference is found in the teacher's command of the training situation by concentrating the focus of the training. The peer communication and modelling cycles are mostly missing from both forms of teaching, although there is variation in the classroom courses depending on the amount of questions presented.

Considering the most basic version of e-learning, Online courseware, the *Cognitive theory of multimedia learning* points out a major difference between classroom and e-learning instruction: the usage of the auditory channel. In classroom instruction the three presentation modes of speech, text, and images drawn by the teacher are commonly utilised. In an online courseware the first is clearly absent if video, audio, or animated content are not used. As creating these forms of content with a quality suitable for commercial distribution is very demanding time-wise – and thus very expensive – they are often omitted, as was the case in the context of this study also.

The *Cognitive load theory* presents three different loads in a learning situation. Regarding the first one, *Intrinsic load*, a living teacher has the possibility of adapting the content and presentation to the capabilities of the learner, whereas a basic e-learning environment does not have such a feature. On the other hand, in the latter form the student can choose to spend as much time as necessary to learn a given piece of content, and in this way adapt the learning process. The second one, *Extraneous load*, can often be found to be unnecessarily great in an e-learning environment, as the initial learning of the navigation and logic of the environment always creates some cognitive load. The third one, *Germane load*, depends on the teaching strategies chosen and as such cannot be counted as a differentiator between the two.

The *Expertise reversal effect* also clearly distinguishes classroom and e-learning content, as a teacher can adjust the teaching at least to a certain degree to suit the level of expertise of an audience. In an e-learning environment consisting of static content the adjustment is again done by the student.

Regarding Wlodkowski's *Motivational framework for culturally responsive teaching*, the most salient differentiator between e-learning and classroom instruction in the context of short commercial computing education courses is the aspect of *engendering competence*, which means that the learners feel that they are effective in learning. In a classroom environment the teacher controls the speed of the course, which can cause a feeling of incompetence, but on the other hand questions can be asked or aid can be requested. In an e-learning environment the situation turns around, as the speed can be controlled by the learner, but no aid is readily available.

The other features of the framework, that is *establishing inclusion*, *developing attitude*, and *enhancing meaning*, are mostly dependent on a given teacher or material. In the context of this study the differences are relatively minimal. Perhaps the greatest difference arises in the last one – especially concerning exercises – as some classroom courses only have small, "hello world" type exercises. Such exercises show the features of a language or framework, but fail to enhance meaning.

6.2.2 Dropout rate in classroom-based courses

Considering the question when analysing the classroom exercises, the following aspects have to be taken into account:

1. The completion percentage counts only exercises that were completed without consulting the sample code for a given exercise. In many cases the student did gain the information even if they had to resort to the samples as was brought into light during the interviews (best summarised in Table 18 on page 96) and when exercise comments were analysed (see subsection 5.1.3.2 on page 85).

2. Even with a total non-completion of an exercise the student had read the exercise for at least some degree, and in most cases the teacher goes through the exercises in front of the class before continuing lecturing. So knowledge is gained even without completing an exercise.

Given these additional notions it can be argued that the dropout in classroom instruction is small indeed, in the vicinity of $0 - 5\%$.

6.2.3 Main reasons for dropout

A major theme of these interviews was that students were generally satisfied with the parts that were understood, in other words learning did happen in spite of inadequate prerequisite knowledge. This is an important aspect when dropout is analysed in the context of short courses – a dichotomous dropout-or-not view is not warranted. Prior course material or a pre-assignment were seen as beneficial, but this was also explicitly asked about, and not everyone agreed that they would use such content.

Otherwise inadequate prerequisite knowledge was by far the most major concrete reason for dropout as seen in these interviews. This reason is very

plausible, but has to be taken with a grain of salt, as it is entirely possible that feelings of incapability have been consciously or unconsciously attributed to inadequate prerequisites. Earlier dropout studies have made a note of such behaviour [95, p. 97].

Considering motivation in course exercises, non-motivating exercises as a dislike towards copy–paste exercises was brought up. This aligns with the information gained from the exercise comments, and is in agreement with the *enhancing meaning* view of the Motivational framework.

The most apparent wishes concerning the course content – whereas not directly related to dropout – were best practices, and a need for examples of architecture. These are understandable as they are facts that a knowledgeable teacher can provide with relative ease, whereas especially architectural solutions would be demanding to present in for example a book format.

6.2.4 Dropout rate in e-learning courses

This section gave a concrete answer to the question of dropout: in the e-learning part of this research the dropout was 80%, with a variation of ±8% given by a 95% confidence interval. The result is in alignment with the figures presented in the introduction.

6.2.5 Main reasons for dropout

The findings of the e-learning interviews were very much in agreement with previous theory. The categories containing features that have in previous studies found to be predictors of dropout did emerge in this study also, namely external and internal factors. Of the external factors, lack of time was by far the most cited reason.

The learner characteristics and learner skills which have earlier had little predictive power, did not also here come forth.

In this research the main motive for conducting the interviews was to create the survey for the next phase; thus the primary reasons found in this section are highlighted in the next paragraphs.

6.2.5.1 Most advantageous factors to aid in e-learning persistence

Considering the *General advantages of e-learning*, all the features that were asked about in the survey did count as very helpful. The factors were, in the order of importance:

- Prepared content (vs. googling)
- One can return to certain subjects, and can search for additional information
- Participation is not timed
- The content can straightforwardly be applied at work assignments
- One can choose on which subjects to concentrate

The findings support the view that e-learning plays an important part in contemporary further education.

A *pleasant user interface* was the most important feature in the *E-learning platform category*. Two other highly valued factors were *information about progress* and *feedback given by the system or the teacher about the achievements*.

In the *E-learning course content* category the most influential factor was *adaptive content*. This is in agreement with the various theories analysed in subsection 3, especially concerning intrinsic load (page 40), expertise reversal effect (page 41), and engendering competence (page 44). Other four noteworthy features are *formative tests, completing a whole application during the exercises*, *final feedback*, and *runnable demos*.

In the *External aspects* category only one factor arose as very helpful, the self-evident *dedicated studying time from work*.

6.2.5.2 Least helpful factors to aid in e-learning persistence In the *E-learning platform* category the factor that gained the least amount of support was *comparison with others*. Almost as ineffectual was *progress monitoring done by the teacher*.

Considering the *E-learning course content* category, the least wished for feature is *competition with other students*. This agrees with the previous category; all kind of comparison has scant support.

In the *External aspects* category *rewards* were the feature that was felt to be least important.

6.3 Theoretical implications

6.3.1 Classroom and e-learning comparison

The theoretical model of analysing instruction, presented in subsection 2.4.2 on page 10 and repeated in Figure 40, was grounded on the *Community of inquiry* theory but reformatted to be more helpful. It aided a lot in assuring that all necessary facets of a teaching setting were adequately covered. The model is hoped to be useful in similar future studies.

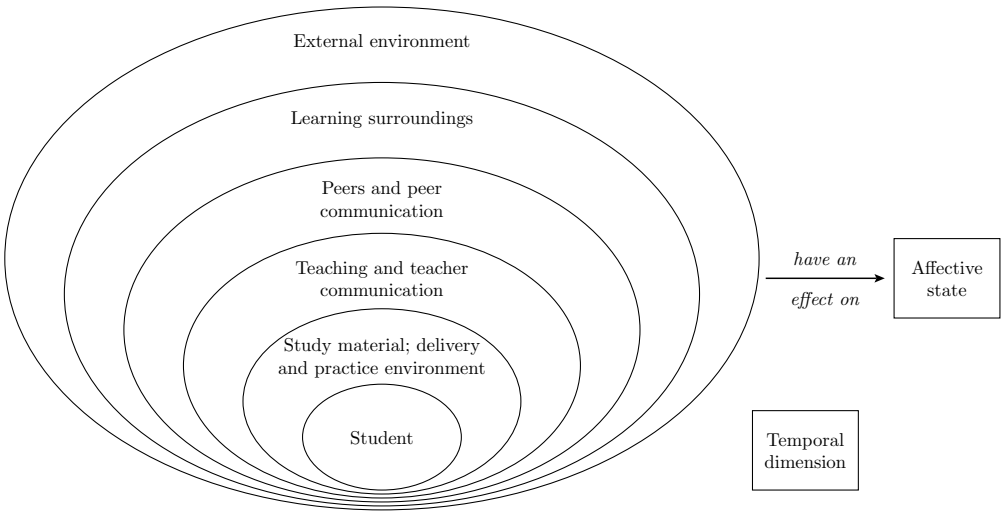

Figure 40: Factors of a learning environment

6.3.2 Classroom dropout

Figure 30 on page 93, titled "reasons for dropout in classroom instruction" shows a view that is both predictive concerning dropout and helpful in finding ways to counter it. When contrasting it with existing theory, many features that have not seen corroboration in dropout studies but which have been present in earlier models, like student background or student learning skills, did not come up when the emergent theory was constructed. This speaks for the validity of the created model, but also validates the findings and model by Park who had questioned the meaning of student features [108, 109]. It would be interesting to see the model developed in this research tested in further studies.

6.3.3 E-learning dropout

As mentioned in the last paragraph, the models of dropout developed as emergent theory in these sections have a special view of finding ways to remedy the phenomenon of dropout. For a long time previous theories tended to be more predictive [95, p. 96], or the more recent studies do not give any weight to the myriad of suggestions found [76, 67, 16, 154]. In this study the interviews and the survey developed according to their findings gave a more precise view of the factors used to remedy the dropout phenomenon. Followup studies are expected to test how these features are implemented and how large a difference they do make.

6.4 Practical implications

6.4.1 Short further education courses in a classroom

Although finding ways to enhance classroom instruction was not a major theme of this study, some important themes were found. The most salient one was that the students should be (1) informed as clearly as possible about the requirements of a course, and (2) coached in some way, or given an opportunity for private study before the course.

Concerning the course content the features most sought after are best practices and examples of complete solution architectures.

And as a smaller factor a dislike towards copy–paste exercises emerged, which is something that the teachers or course content creators should make a note of.

6.4.2 Short further education courses delivered as e-learning

An important giveaway of the whole research were the suggestions how e-learning in the context of the study could and should be improved in relation to dropout, and conversely what improvements are likely to have little effect. The most important of these have been described in the summary subsection 6.2.5 on page 123.

6.5 Limitations and transferability

6.5.1 Limitations of classroom dropout

The amount of students from other trainers were unfortunately relatively small. With a larger amount it would have been possible to analyse various effects

between teachers.

Similarly the amount of possible interviewees remained low, and thus the Grounded theory method recommendation that interviews are stopped when no new information arises was not clearly met.

A feedback system had been utilised by the company for about 15 years. The responses of the classroom exercise reporting results were not contrasted with feedback entered into the system, as the questions were very general in nature, and did not ask for feelings about learning or program fit, which would have been most useful regarding this study.

6.5.2 Limitations of e-learning dropout

As the e-learning content was a prerequisite to other courses, it is likely that most students already have a level of command in the subject. This has two implications: (1) the dropout percentage is probably higher than with students that have come to study the exact subject that the e-learning course is offering, and (2) the possibility of Expertise reversal effect increases, thus colouring the interview and survey responses.

The final survey did not – unfortunately – have a scale that would ask for features possibly having even a negative effect on e-learning. This limits the inferences that can be made from the results.

As the course was more voluntary in nature than the classroom version, pre-tests and post-tests might have been possible to measure the learning effect. However such is left as an idea for further research, as the participants typically have tremendously busy work schedules, and it is very possible that even a simple test at the beginning would have caused several students immediately to drop out of the course.

6.5.3 Transferability

It is unlikely that the results can be transferred to environments outside adult education targeted at software development professionals.

Firstly, the motivation of adults differs from younger age groups as the subject of the courses is directly related to their occupation. Secondly, software development professionals are typically more adept at using computers than the general adult population.

Furthermore, the course contents are rather objectivist in nature, and as such many social features that would definitely be helpful in many other subject areas do not carry such importance in this case [116].

These insights are in agreement with previous research, which has shown that one should be wary in transferring results between contexts in dropout research. Quoting from [146]:

> "Caution needs to be taken when generalising the results of this study. Each online program is unique and the reasons given for leaving a program may be specific to the nature and uniqueness of the program."

6.6 Recommendations for further research

6.6.1 Classroom

It is suggested that the findings of this study are further corroborated by conducting more interviews with dropped out students. Then a more precise view of the phenomenon can be obtained, possibly by continuing with surveys.

If feasible in another setting, pre-tests and post-tests of learning could be interesting to conduct to give a more precise definition to the dropout phenomenon.

As a new outlook on the subject, involuntary participation is a feature that could be more precisely investigated by interviews.

6.6.2 E-learning

As the most burning question, followup studies are expected to test how the improvement suggestions found in this study could – and should – be implemented, and how large a difference they do make. Especially adaptive content is a feature that has been brought up both in this study and in the theoretical analysis comparing classroom and e-learning instruction (intrinsic load of subsection 2.4.3.4 on page 20 and expertise reversal effect of subsection 2.4.3.4 on page 22).

Related to the suggestion of the previous paragraph is replicating the survey of this research but with a scale analysing also possible negative effects of various e-learning features, as discussed in the limitations section above.

Another, more straightforward research idea is to alter the basic Online courseware type of e-learning that was used in this study, and replace it with a version having more social features like Online distance education or Online collaborative learning. This approach however is likely to be of less use in the context of this study, as social features did not gather strong support in the e-learning survey.

As a more minor research suggestion for validating the findings of this study is a version that could find out about the possible Expertise reversal effect and how much impact it has on dropout.

And as with classroom instruction, pre-tests and post-tests of learning could be interesting to conduct to give a more precise definition to the dropout phenomenon.

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Appendices

A The Conversational framework

A.1 Background of the framework

The Conversational framework has been formed by combining insights given by various theories of learning into a single representation of Figure 41 on the next page [73, p. 60]. It shows the following:

- The learner learns by using personal goals and current conceptual organisation to select from their current practice capability to generate actions on the external environment
- The learner can use an action modelled by a teacher, or use results from her own action to modulate and build her practice capacity
- What she gets from the teacher or environment may modulate her current concept, personal goals, or current practice capability, and so generate new actions in a continuous iterative process of development and learning
- If a teacher is present, there is also the opportunity to learn via communication – from the teacher's explanations of their conceptual world
- The learner may generate her own articulation of the teacher's explanations, or may use the information from the interaction with the external environment to modulate her concept and generate articulations of it, again in a continuous iterative process
- The cycles may also begin with the learner's goal generating an articulation to elicit a response from the teacher, or generating an action to elicit a result in the environment

The Figure demonstrates in how many different ways it can break down, especially when the one-to-one iteration between learner and teacher is so rare.

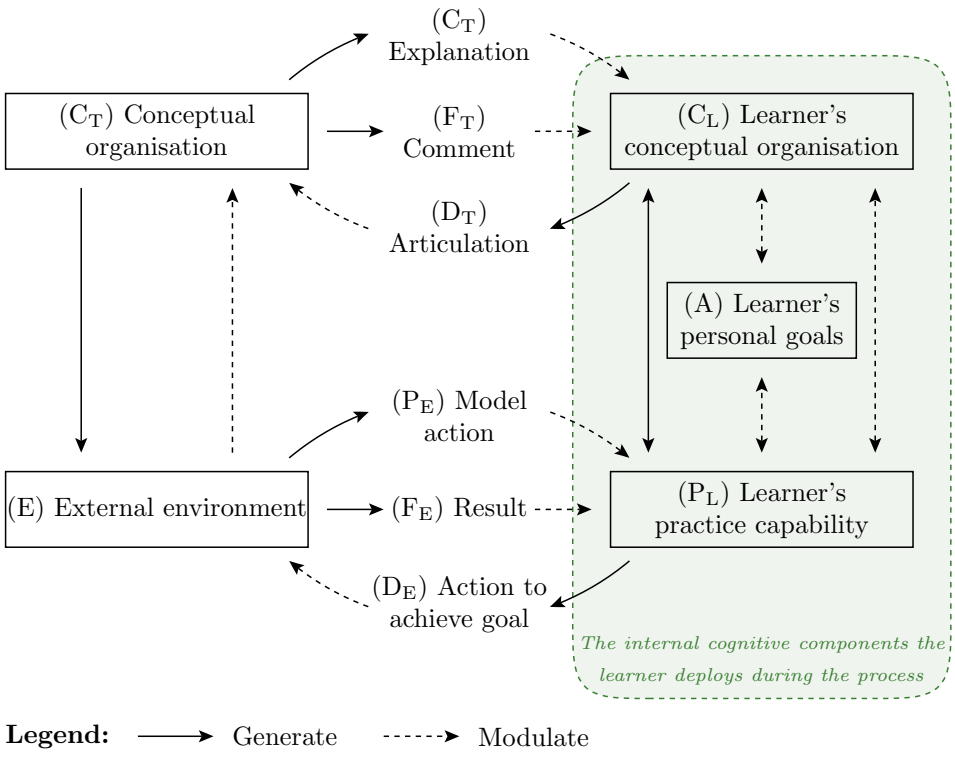

Figure 41: Consolidation of theories in learning (redrawn from [73, p. 60])

A.2 Internal learning process elaborated

Figure 42 on the following page shows an alternate representation of the internal learning process that was developed in Figure 41 [73, p. 86]. The learner interacts with the teaching–learning environment at two levels: by generating articulations of their concepts, and by acting on the external environment (TPME = *teacher practice/modelling environment*); and they receive feedback on both. Put most simply, the role of the teacher is to motivate the internal cycles generating and modulating the learner's concepts (C_L) and practice (P_L) – these aspects facilitate learning.

The links in Figure 42 on the next page are drawn as double lines to indicate the continuous iterative cycles that enable the learner to develop their concepts and practice in the way the teacher has intended. The interactions vary both in time and form. The time may have a span of a few minutes to several weeks. The interactions vary from discussions linking teacher and learner concepts, to practice tasks where the teacher provides the practice environment, and to mixes of both. The teacher is not always present, and thus the learner is supported by the teacher represented in the form of textual presentations, videos, and work in the practice/modelling environment (where there may be e.g. practice exercises, projects, labs, or programs).

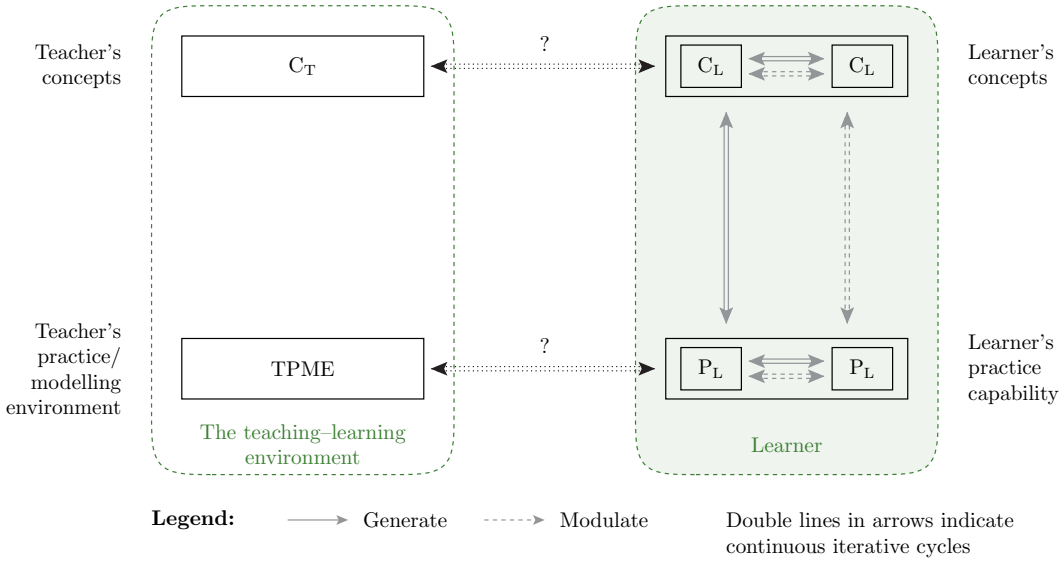

Figure 42: The learner learning while interacting with the teaching–learning environment (redrawn from [73, p. 86])

A.3 The framework

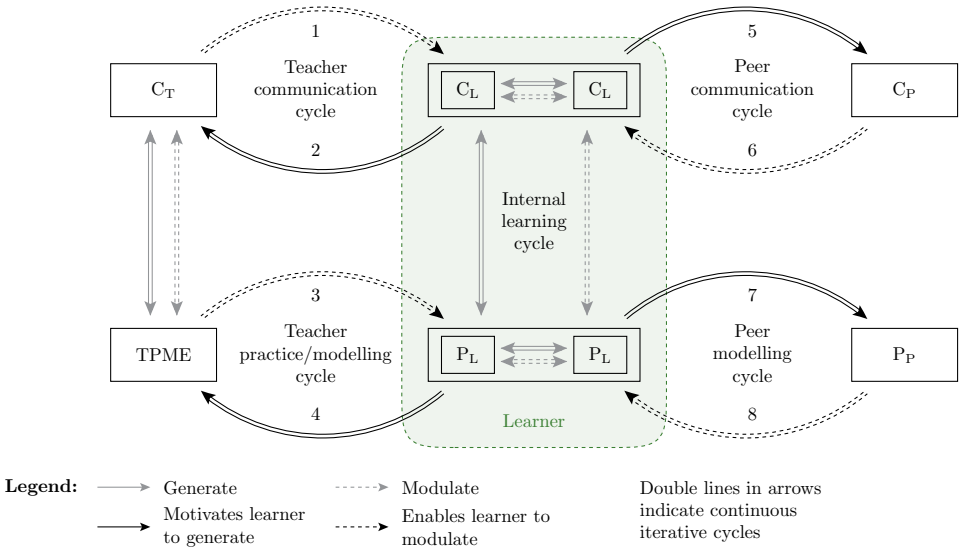

Figure 43: Laurillard's *Conversational framework* (adapted from [73, pp. 92, 95])

The ways in which the teacher and other learners motivate the iteration in the internal learning cycle are explicitly defined as follows (number referring to the activities in Figure 43) [73, p. 94].

The teacher communication cycle (TCC)

(1) enables each learner to modulate their concepts by providing access to the teacher's concepts

(2, 1) motivates each learner to generate questions or articulations of their concepts and practice as the teacher is giving extrinsic feedback

The teacher practice cycle (TPC)

(4, 1) motivates each learner to modulate their practice by generating actions that elicit extrinsic feedback from the teacher

The teacher modelling cycle (TMC)

(4, 3) motivates each learner to modulate their practice by generating actions that elicit intrinsic feedback from the modelling environment

The peer communication cycle (PCC)

(6) enables each learner to modulate their concepts by providing access to their peers' concepts

(5, 6) motivates each learner to generate articulations as they get extrinsic feedback from peers

The peer modelling cycle (PMC)

(4, 7) motivates each learner to generate actions in their practice environment because they are sharing the output of their practice

(8) enables each learner to modulate their practice by using the model of their peers' output

To sum up the principles that the formal framework is based on: The aim of the teacher's design is

- to *motivate* or *enable* the learner...
- to *generate* their *articulations* and *actions*...
- that *modulate* their *concepts* and *practice*.

and this is achieved by designing a teaching–learning environment, which provides design elements for each of the activities in each communication, practice, and modelling cycle listed in Table 26 on the next page.

Table 26: Design elements mapped to activities within the Conversational Framework cycles

Cycle	Design elements
TCC1	Access to the teacher's concepts
TCC2	The means to articulate their concepts and reflections on practice
TCC3	Extrinsic feedback on questions or articulations of their concepts
TPC1	A practice environment that facilitates their actions
TPC2	Extrinsic feedback on their articulations of their actions
TMC1	A modelling framework that elicits their actions
TMC2	Intrinsic feedback on their actions from the model
PCC1	Access to peers' concepts
PCC2	The means to articulate their concepts and reflections on practice
PCC3	Extrinsic feedback from peers on articulations of their concepts
PMC1	Sharing practice outputs with peers
PMC2	Access to peers' outputs as a model for their practice
ILC	Generation of actions; modulation of concepts and practice capability [73, p. 185]

The cycles of the Table 26 are shown also in Figure 44.

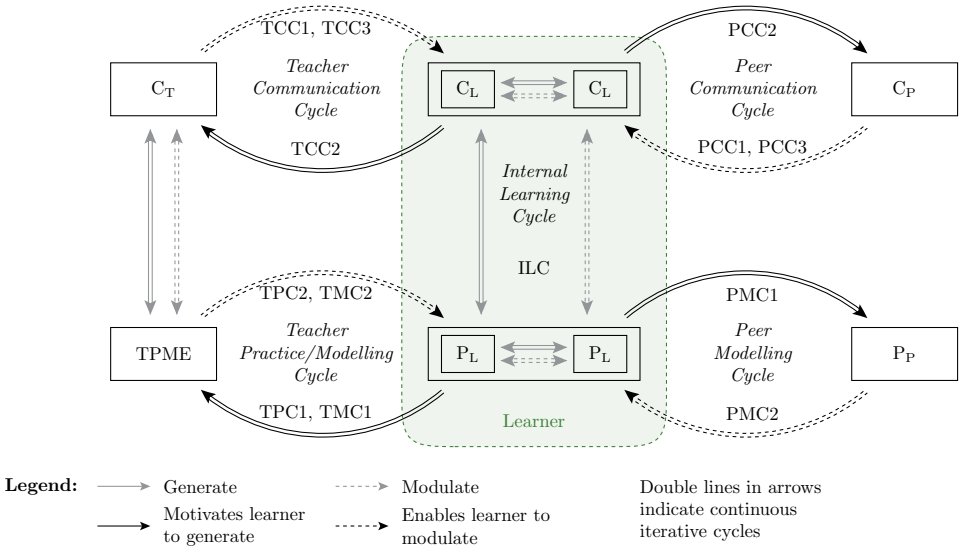

Figure 44: Design elements mapped to activities within the Conversational Framework cycles (redrawn from [73, p. 92])

B Classroom exercise reporting application: Student features

Background skills that vary from course to course:

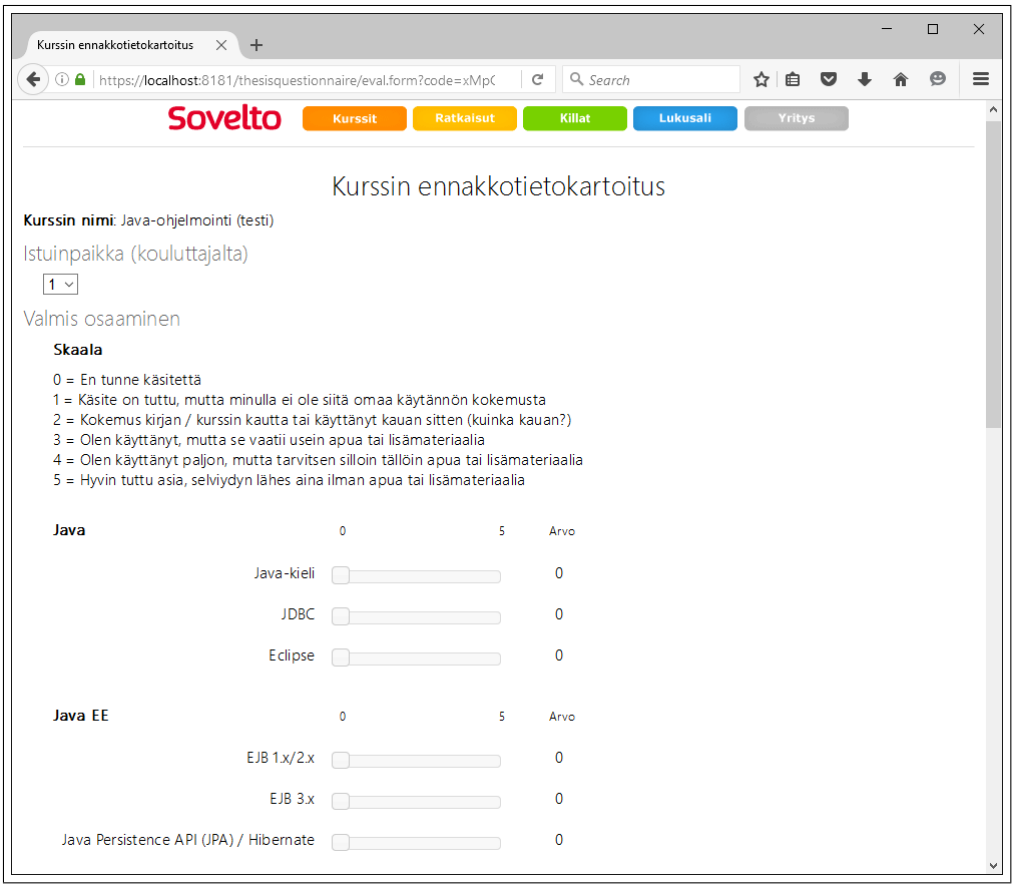

Figure 45: Classroom reporting application: Background skills

Static background questions:

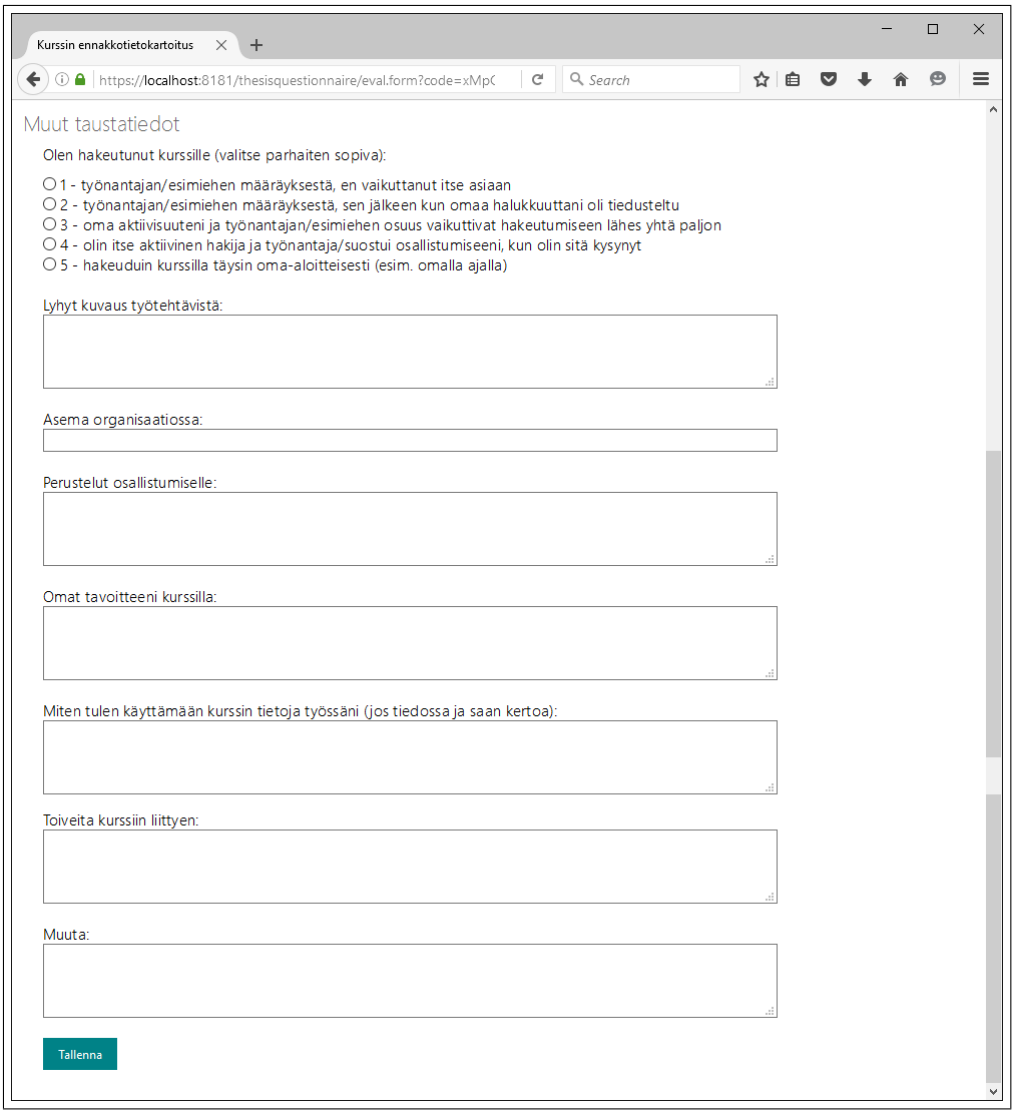

Figure 46: Classroom reporting application: Background questions

Figure 47 shows the instruction leaflet given to the student.

Sovelto

Aalto University
School of Science

Luokkakurssien edistymisseuranta

Kurssilla seurataan harjoitusten edistymistä web-pohjaisella sovelluksella. Seuranta liittyy luokka- ja eLearning-kursseja vertailevaan lisensiaattityöhön.

Nimitietoja ei julkaista. Nimitietoja ei tallenneta tutkimuksen tai sen mahdollisen väitöskirjajatkon jälkeen.

Tutkija: DI Panu Korpela, tietotekniikan opetustutkimus / Aalto-yliopiston perustieteiden korkeakoulu
Valvoja: prof Lauri Malmi, tietotekniikan opetustutkimus / Aalto-yliopiston perustieteiden korkeakoulu

Sovelluksen ensimmäinen sivu on taustatietojen kysely. Tämän jälkeen saat henkilökohtaisen osoitteen, jonka avulla voit raportoida harjoituksissa edistymistä (kuva alla). **Huom.: Jos hävität osoitteen, saat sen uudelleen kouluttajalta, eli älä täytä alkuhaastattelua uudelleen.**

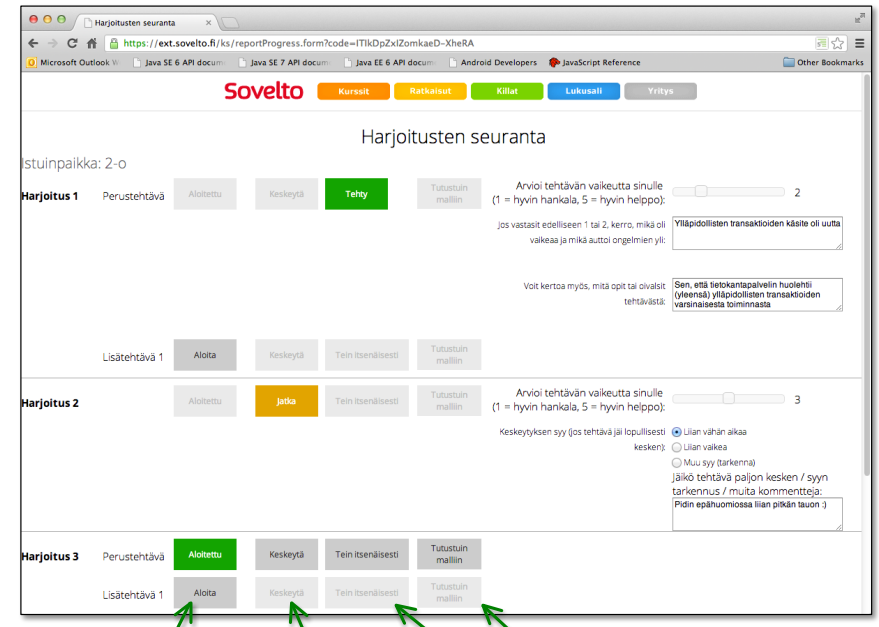

Figure 47: Student leaflet

The classroom interview description is shown below.

Research project description

1. Contact information

Researcher: M.Sc. (tech.) Panu Korpela, postgraduate student of computing education research at Aalto University, *email address*, *phone number*

Supervisor: Prof. Lauri Malmi, computing education research / School of Science of Aalto University

2. Research subject

Comparison of classroom and e-learning teaching in training of software developers

> In this case the concept of "e-learning" is used to mean independent studying utilising material that is accessible via a network using a web browser

3. Concrete implementation of material collection, and estimated duration

The material for this phase of the research is gathered via interviews. Estimated duration of an interview session is 30 minutes, usually somewhat less.

4. Research subject

Research setting and result reporting are confidential. Information gathered from the research will be limited to the research group use only, and the results will be published in research reports so that a single participant cannot be identified.

5. Participation voluntariness

Participation is completely voluntary. A participant will be rewarded with two Finnkino's movie tickets.

The start of the user interface of the e-learning survey is in Figure 48.

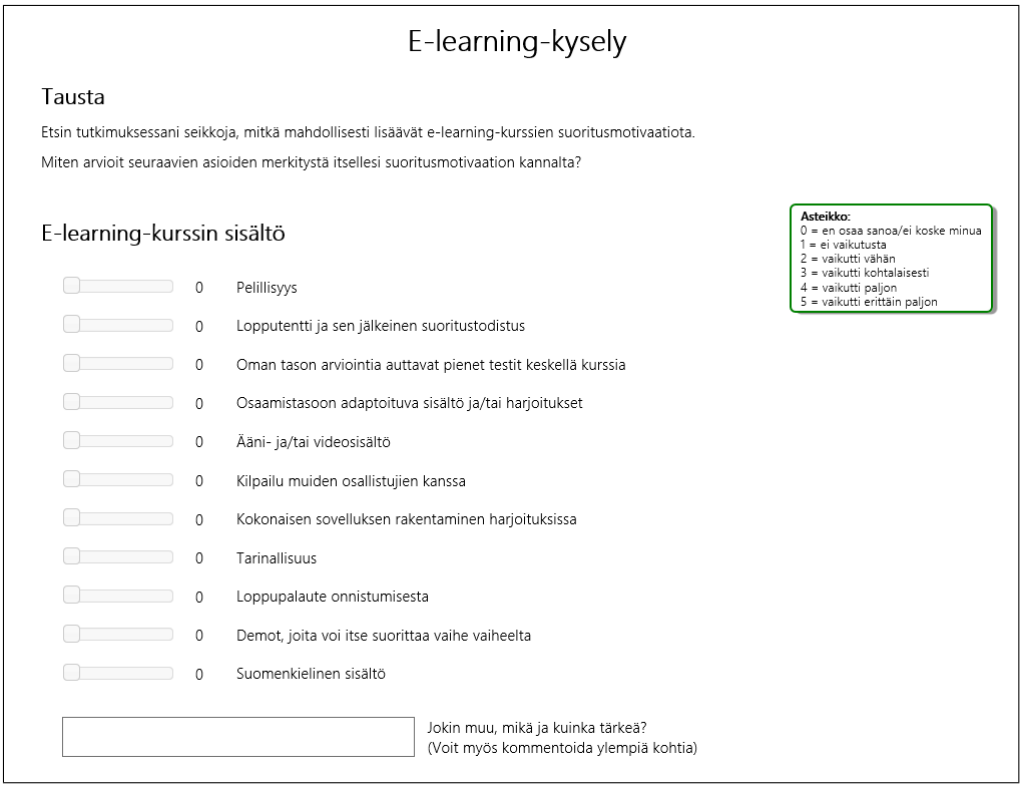

Figure 48: E-learning survey

C Classroom exercise reporting application: Teacher features

The start of the instructions given to each teacher can be seen in Figure 49.

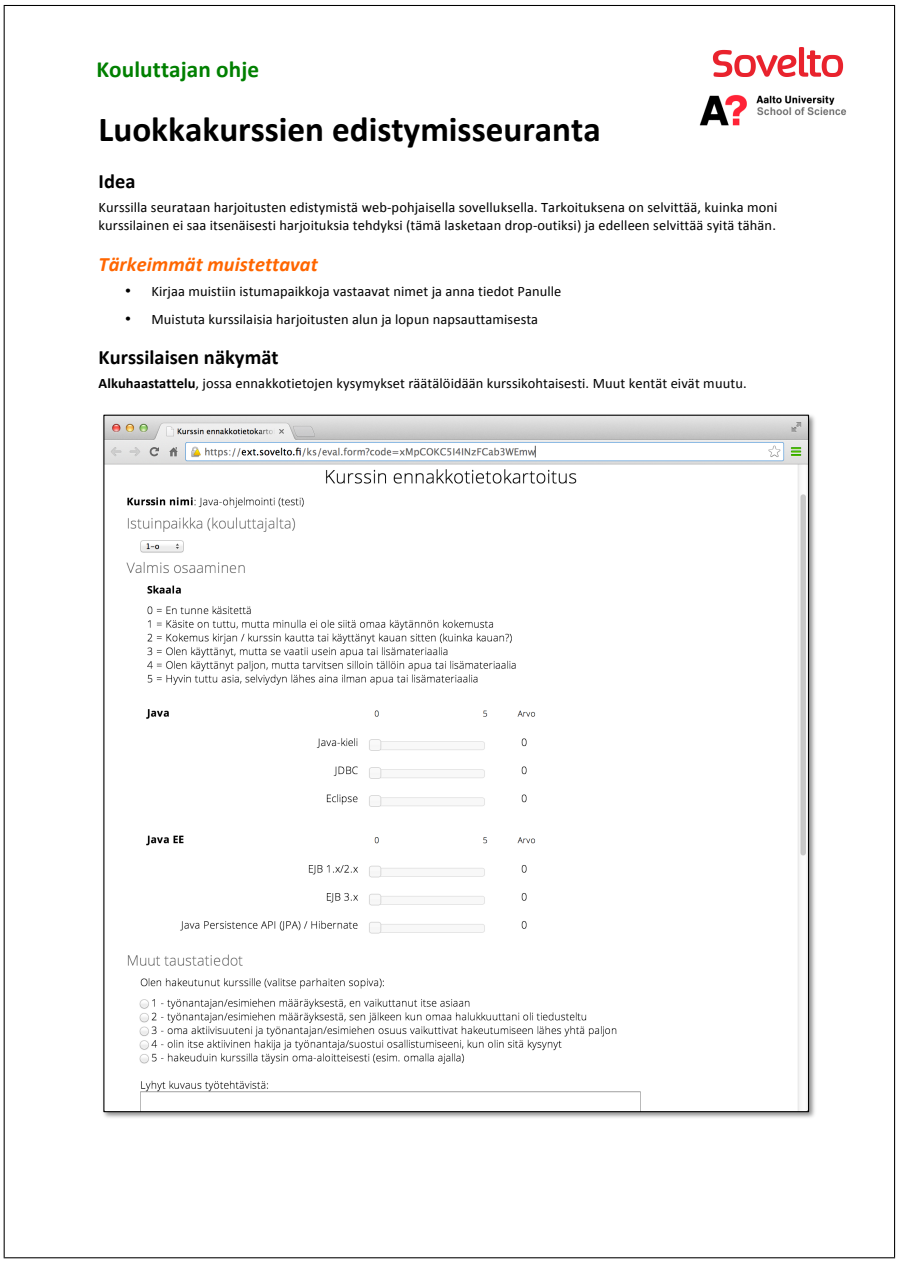

Figure 49: Classroom exercise application, teacher leaflet

The configuration interface used by the teacher to assign skills to be asked about from the student is shown in Figure 50. The same interface is used to mark seats, exercises, and extra exercises for the course.

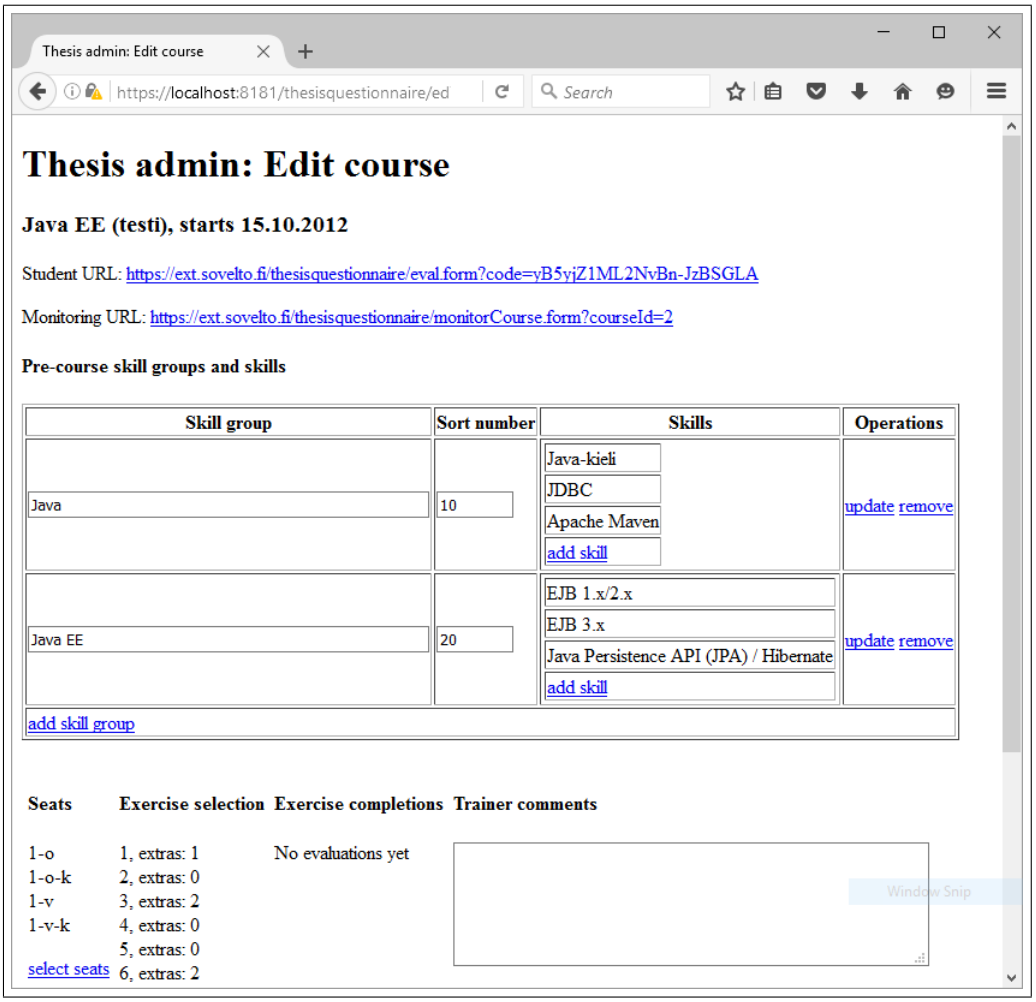

Figure 50: Classroom exercise application, teacher configuration view

The teacher had a monitoring interface to see in real-time how the students progressed in the exercises. This is shown in Figure 51 and in Figure 52 on the following page.

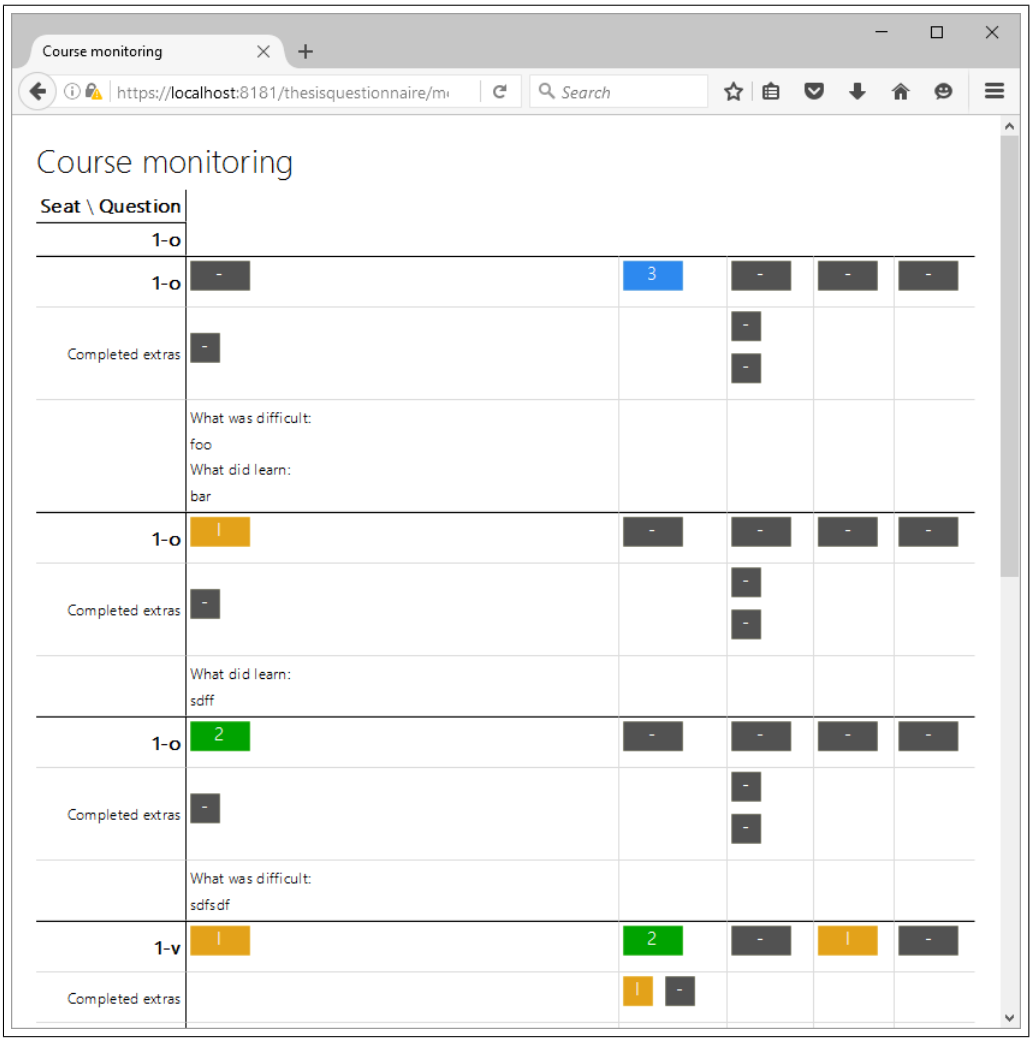

Figure 51: Classroom exercise application, teacher configuration view (top of page)

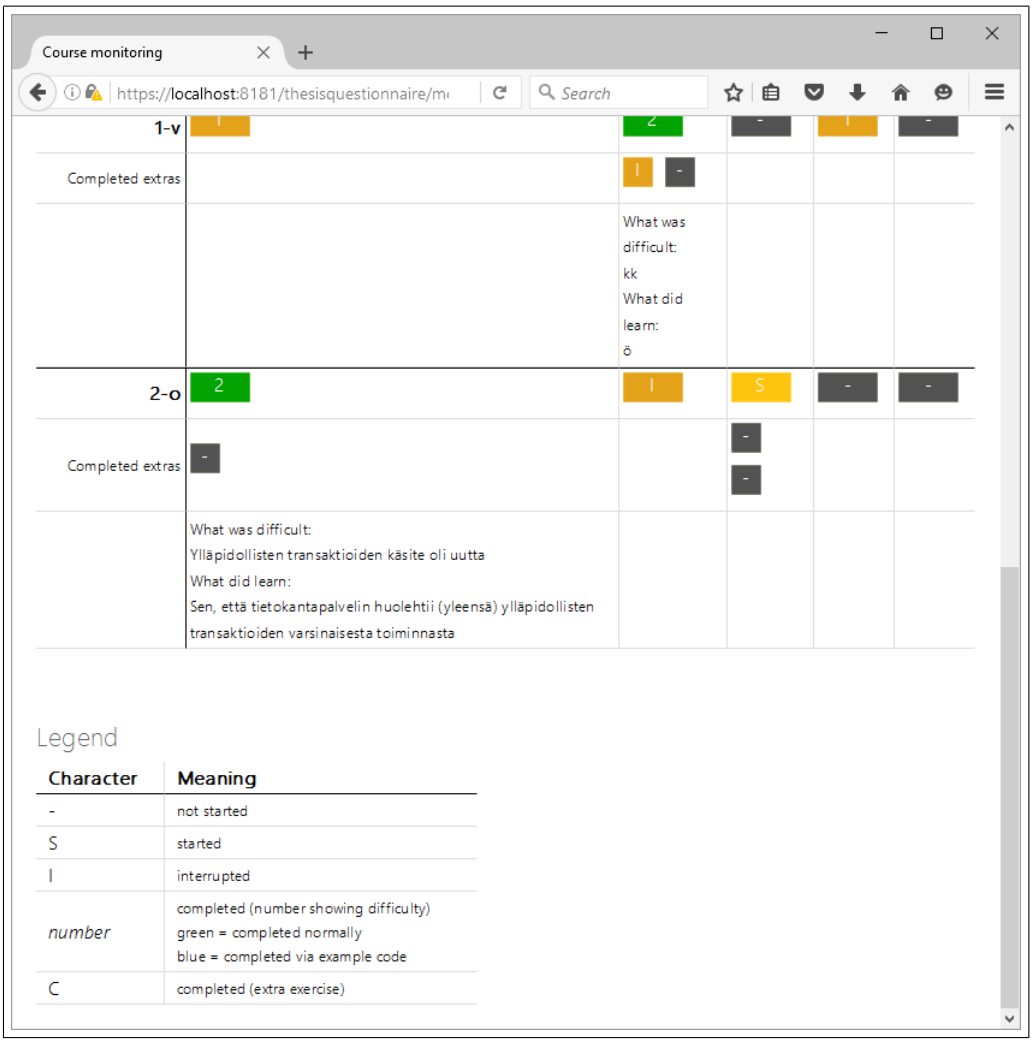

Figure 52: Classroom exercise application, teacher configuration view (bottom of page)

D Teacher descriptions

D.1 Teacher 1 (the researcher)

The teacher has been instructing programmers since 1996 with a focus on Java and web programming techniques. He has himself written all the material for the courses taught by him.

He has a M.Sc. (Tech.) degree from Helsinki University of Technology in Engineering physics.

The courses involved in this research taught by him are titled as, in alphabetical order:

- HTML5 and CSS3 for software developers
- HTML5 and CSS3 for software developers (open source)
- Java EE
- Java EE advanced: Bean Validation and CDI
- Java language and object-oriented programming basics
- Java programming
- Java: XML ja Web Services
- JavaScript
- JavaScript and jQuery
- JavaScript and jQuery for Java programmers
- JavaScript programming, part 1: Basics
- JavaServer Faces (JSF 2.x)
- Modern Java EE application
- Modern web site with jQuery
- PHP
- Spring framework
- Testing in Java EE development
- Web development: JavaScript and jQuery

D.2 Teacher 2

The teacher has been instructing programmers since 1997 with a main focus on Microsoft .NET and web programming techniques. Regarding the former area the major foci are SharePoint and BizTalk related software development courses. To a great degree he uses material written by others or delivered as Microsoft official course material, although some courses use material developed by him.

He has a half-completed M.Sc. (Tech.) degree from Helsinki University of Technology in Engineering physics.

Courses related to this research:

- 10953 HTML5 Programming (Microsoft's course material)
- 20480 Programming in HTML5 with JavaScript and CSS3 (Microsoft's course material)
- 20488 Developing Microsoft SharePoint 2013 Core Solutions (Microsoft's course material)
- 20489 Developing Microsoft SharePoint 2013 Advanced Solutions (Microsoft's course material)
- AngularJS
- Microsoft BizTalk Server 2010 software development

D.3 Teacher 3

The teacher has been instructing programmers since the 1980s targeting various Microsoft programming techniques. He likes to concentrate on cutting-edge technologies rather than using his time to hone existing course material. He utilises all the material versions: self-written, Microsoft official material, and content written by other teachers.

He has a M.Sc. (Tech.) degree from Helsinki University of Technology in Engineering physics.

Courses related to this research:

- ADO.NET programming advanced: Entity Framework and LINQ
- HTML5 services: ASP.NET Web API
- Node.js and TypeScript programming with Visual Studio
- Windows Communication Foundation programming

D.4 Teacher 4

The teacher has been instructing programmers since the 1980s with a main focus on basic Microsoft programming techniques as well as database programming. He also utilises all the material versions as the previous teacher.

He has a M.A. degree from University of Helsinki in Computer science.

Courses related to this research:

- 20486 Developing ASP.NET MVC 4 Web Applications (Microsoft's course material)
- ASP.NET MVC
- C# and .NET Framework programming

E Some classroom course descriptions

Translated from Finnish preserving the original wording as closely as possible. In some cases the original sentences had structural errors; also these have been retained.

AngularJS

Description

AngularJS is a JavaScript library maintained by Google that can be used to implement browser web applications based on the MVC model (Model–View–Controller). The idea of AngularJS is to be what HTML should have been if HTML would have been designed for creating applications.

AngularJS is suited for the creation of both demanding LOB clients and simple web applications. It is a very productive way to implement SPAs (Single– Page–Application). The MVC model disconnects data, browser logic, and user interface from each other into easily controlled and maintained fields. This enables also TDD (Test–Driven–Development) for AngularJS solutions automatised unit and end-to-end tests can be written.

AngularJS demands a big mindset change from the browser developer, but getting acquainted pays itself back by improving the productivity of browser development. AngularJS gives a vision of what a browser application architecture should be. No more spaghetti code. On this course the version 1 of AngularJS is handled

Prerequisites

On the course it is assumed that the person attending the course possesses command of JavaScript.

ASP.NET MVC

Description

ASP.NET MVC is a Model–View–Controller architecture, which is a new way for implement web applications in the Microsoft world. An application consists of three logical parts: a Model, a View, and a Controller. The architecture enables a more controlled way of maintaining the user interface, the business logic, and the Data Access layer when compared to Web Forms programming. Other benefits are among other things a more tightly controllable html sent by the browser and for example search engine and user friendly URL addresses. Unit testing enables the usage of a Test Driven Development method in development. The course is delivered using the ASP.NET MVC version 4, and the tool used is Visual Studio 2012.

Prerequisites

The course requires command of the content of the 'C# .NET Framework programming' course and basic knowledge of the ASP.NET technique.

C# and .NET Framework programming

Description

This is the ground course for all persons taking part in C# software development, like software developers, software architects, and project managers. All the follow-up .NET courses have been designed so that the participants have a command of the knowledge and skills offered by this course.

This course gives a readiness for .NET development work using the C# language. On the course one learns the core know-how for all types of C# .NET development. On the course the syntax of the C# language, and the services of the .NET Framework class library are covered. Database handling, web applications, and the Windows Presentation Foundation will be covered as an overview, and for those as well as for other fields there exist advanced follow-up courses. The course is delivered using the Visual Studio 2012 and the .NET Framework 4.5 versions.

Prerequisites

The course requires programming know-how in the Windows environment with any tool. For the persons lacking such know-how, the course 'Basics of C# programming' is suggested to be taken first.

20486 Developing ASP.NET MVC 4 Web Applications[34]

Description

ASP.NET MVC is a Model–View–Controller architecture, which is a new way for implement web applications in the Microsoft world. An application consists of three logical parts: a Model, a View, and a Controller. The architecture enables a more controlled way of maintaining the user interface, the business logic, and the Data Access layer when compared to Web Forms programming. Other benefits are among other things a more tightly controllable html sent by the browser and for example search engine and user friendly URL addresses. Unit testing enables the usage of a Test Driven Development method in development. The course is delivered using the ASP.NET MVC version 4, and the tool used is Visual Studio 2012.

Prerequisites

Knowledge comparable to the ASP.NET Core course

20488 Developing Microsoft SharePoint 2013 Core Solutions

Description

Do you know the new development possibilities of SharePoint 2013? How to choose the correct means of customisation, and to implement it? How are application packaging, deployment, and upgrading implemented correctly? How the data and data structures are modified? How the diagnostics and debugging

[34]Same description as on the ASP.NET MVC course above

of an application are implemented? How the application is designed so that it scales and fulfils the performance requirements? How are authentication and authorisation implemented? Do you know Azure and SharePoint Online?

After the course you have a broad picture of what possibilities SharePoint 2013 gives to the application developer, how software development is carried out on top of SharePoint 2013 and you can choose the best technique for implementing solutions on top of SharePoint.

Prerequisites

Previous ASP.NET development background and a basic knowledge of SharePoint concepts are desired of the students.

F JavaScript course content

General about the JavaScript language

- browser support; ECMAScript
- possibilities of having an effect: dynamic browser applications and present-day server programming

Tips for practice

- browser developer tools
- debugging

Placing the code on a page

- code in a HTML file
- linking an external file
- contemporary practices

JavaScript language syntax

- basic syntax, data types, and variable declaration
- arrays
- JavaScript's objects; object as a literal
- built-in objects
- operators
- conditionals and loops
- functions; function as a variable scope

Attaching a event handler

- attachment possibilities
- browsers' handlers
- unobtrusive JavaScript

Browser object model

- window object's children
- W3C DOM
- innerHTML
- programmatic creation of elements

G Invitation counts and login rates

Invitations done between late 2013 and 18.8.2014 – without mentioning the course content to be about the JavaScript language – are listed in Table 27, and invitations on or after 22.8.2014 – with a mention of the course content to be about JavaScript – are listed in Table 28.

The page-by-page movement analysis in the e-learning content was added to the e-learning server infrastructure before the two last invitation groups in the first table. So altogether 88 invitations were sent when this logging was in place, and 31 students of these logged on to the system.

Table 27: E-learning invitations sent to students without mentioning the content to be JavaScript

Classroom course #	**Number of e-learning invitations sent**	**Number of students that logged in to the e-learning system**
1.	9	5
2.	12	9
3.	2	2
4.	9	0
5.	4	4
6.	8	5
7.	4	1
8.	11	2
9.	9	1
10.	11	2
Total →	**79**	**31**

Table 28: E-learning invitations sent to students with mentioning the content to be JavaScript

Classroom course #	**Number of e-learning invitations sent**	**Number of students that logged in to the e-learning system**
11.	16	6
12.	14	6
13.	11	3
14.	4	2
15.	4	1
16.	10	5
17.	6	3
18.	3	2
Total →	**68**	**28**

The login rates were 39.2 % for the first group and 41.2 % for the second. A chi-square test was performed and no relationship was found between groups

of mentioning or not mentioning the JavaScript content and the login rates, $\chi^2\,(1, N = 147) = .057$, $p = .811$.

As there was no relationship, the two last invitation groups of the first table were included in the e-learning quantitative analysis – the first eight invitation groups did not have anything tangible to use for research other than login percentage.