Looking for Usage Patterns in e-Learning Platforms
a step towards adaptive environments

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Abstract: This paper studies the student view of functionality offered by a research-based design of a blended learning environment. The course in question is a Software Engineering course at the Cooperative State University students alternate between study and work in a quarter-based system and complete their study in three years. Based on findings over the last year, the course is currently using an e-learning platform (Coursesites by Blackboard) to enhance the on-site classroom experience. For this paper, students were asked to rate the usefulness of various functionalities offered by the platform. The results of the survey (77 students) are then used to explore patterns of usage. We use Grasha's theoretical definition of six learner-stereotypes to derive an exaggerated usage pattern for each. While students do not match stereotypes, usage patterns become evident in the degree to which they match a combination of these pure definitions. According to groupings of common manifestations, the student body is highly fragmented in their preferred use of the platform. Maintaining Grasha's nomenclature according to the most pronounced stereotype in a pattern, these students consisted of 38% "avoidant" user type, 27% "collaborative/participant", and 10% "competitive" usage pattern. A single platform will not cover any mixed group of students and configurable views need to be considered in future.

1 INTRODUCTION

This paper is the fourth in a series of publications about the results of gamifying a course in Software Engineering. The gamified version of the course exposed issues with difficulties in self-regulated learning in students and an important dissonance between the seriousness of study and the perceived inappropriateness of comparing it with a "game" (Berkling et al, 2013b). Following this, a detailed study of the mismatch in motivation between students in a restricted ecosystem (namely grades and passing) and assumed universal motivators like autonomy, mastery and purpose (Pink, 2010) was explored in detail (Berkling et al, 2013a). Results show that scaffolding and a simple work environment suitable to cover a large spread in students' needs was important. Based on these experiences, a third publication (Thomas et al, 2013) explored theoretical solutions in more detail relating tool capabilities to learner types that seemed to match most closely with the student profiles encountered in past courses. This work was done jointly with a Bachelor student at the University and thus allowed for insights from student body blending into the resulting work. In this publication, the choice of Coursesites (an e-Learning platform provided by Blackboard) is explained in detail. In summary, the platform supports group work, grade overview, content sharing, forum, group spaces, and collaborative aspects. These functionalities were important criteria for the choice of platform in order to support the goal of creating autonomous students who pursue mastery and purpose in their learning. Having a tool that supports scaffolding for this path towards self-regulation was a key outcome of our previous work in this area. Coursesites is used with this end in mind, providing a plethora of functionality to be used, while not expecting all students to use these equally. This publication extends the previous work by looking at how students have been using the functionality provided by Coursesites in order to verify the existence of subgroups of users that use the platform in different

ways. A student survey was conducted for 77 students currently engaged in the class to study which features of the platform are most used and whether there exist any patterns in usage for any definable subgroups.

The paper is structured as follows. After a review of the theoretical foundations for this work in Section 2, Section 3 will explain the design of the survey. Section 4 will discuss results that show how functionality usage can describe groups of student learner types. Section 5 offers a brief discussion on how various platforms might then fit to student learner types, followed by a discussion and future work section.

2 THEORETICAL FOUNDATION

The software engineering course was redesigned around motivators with content and platforms aligned as shown to be important (Derntl, 2005). For example, if self-regulation and autonomy is an important learning outcome then an e-platform can support this goal by providing a team-based to-do list or the possibility to advance through topics at personal speed. If mastery is important then multiple submissions could be allowed along with an up-to-date view of current grade. If scaffolding is needed, the progressive unlock of content can be enabled. The content must match the level of the student and the tasks designed to allow students independent work that can be shared if collaboration is important to the student. For competitive learners performance is important and the platform can provide class average grade for each assignment. All these dimensions were explored in detail in previous publications and led to the usage of an extensive e-platform to support this kind of teaching environment for different kinds of learners. Learner types and the chosen platform are briefly reviewed here for context of the current study.

2.1 Learner Types

According to Susan A. Santo (Santo, 2006), there is no generally accepted definition for learning styles despite the fact that many different learning style models exist. For the purpose of this paper, Grasha's definition of a learning style as somebody's preferred way of learning (Grasha 1994; Fuhrman 1983) is sufficient because they are used as stereotypes for a first approximation in an iterative approach to understanding subgroups of students' usage of platform functionality. According to the Grasha-Riechmann Student Learning Style Scales, there are six styles that can be differentiated amongst learners as given in Table 1. For the purpose of this work, these profiles represent theoretical stereotypes; based on their description, we will define characteristic platform usage profiles. The usefulness of such profiles will be validated if they prove helpful as an intermediary step in defining homogeneous subgroups of user profiles with respect to how the e-platform is used by this subgroup.

Table 1: Learner Types.

The **participant** learner is very interested in the course content and asks questions.
The **avoidant** learner works as little as possible or only shortly before a dead-line.
The **independent** learner works on his/her own and rarely asks for help.
The **dependent** learner needs lots of support and detailed instruction.
The **collaborative** learner prefers working in a team.
The **competitive** learner wants to do better than other course participants.

We use Grasha's theoretical definition of six learner-stereotypes to derive an exaggerated e-platform usage pattern for each. Because students do not match stereotypes, usage patterns become evident in the degree to which a student matches a combination of these pure definitions. If common manifestations exist, then the student body can be described in such terms as subgroups.

2.2 Learning Platform

To enable a blended classroom of more than 70 students with technology, various platforms were considered. In (Thomas et al, 2013) three online learning platforms were evaluated for our purpose based on developed guidelines that supported learning styles and adequate functionality. At the time, CourseSites offered the best choices to implement Software Engineering as a flipped classroom, with the deciding factor towards its ability to have a team space. For the Fall 2013 class, a course was created on this platform using various features. Key to choosing a tool is to reassure that it supports the design criteria and necessary processes in the classroom explained in more detail in previous publications. In that sense, CourseSites is replaceable by any other MOOC (Massive Open Online Course) platform that supports the needed functions. The hypothesis at the time was that students will use the tool in different manner according to their learning style. In this paper

students were asked to rate the functionality. If the hypothesis holds true, then students should fall into categories based on their use of the functionality. For this purpose, a survey was conducted asking students about their opinion on the importance of the spectrum of functionalities. This survey is explained next.

3 STUDENT SURVEY

After using coursesites for 6-7 weeks, students where queried on the importance of certain functionality groups of their learning platform. While students have had limited experience with the platform at hand, students have been using Moodle for a long time, including high school. Some students have taken MOOCs but all of them have experience with any number of online social communities. From this point of view, they were asked to evaluate not the platform or its content but the functionalities it offers, assuming that the functionality was implemented well. Evaluation was based on a four point Likert scale from "totally irrelevant" to "very important". In addition, the possibility for "other" or "don't know" was allowed. 77 computer science students currently enrolled in the course answered the survey during class time.

3.1 Functionality Groups

In order to ask students about all functionalities, the various aspects of any platform were listed according to the possible dimensions as shown below – the complete list is given in Appendix A:

- Content dimension: self-made, peer-made, professionally made, static, dynamic, personalized, logical content, illogical content, mixed content.
- Time dimension: synchronous (classic course), asynchronous (on demand/on progress), mixed
- Grading dimension: grades based on: forum entries, likes, homeworks, peer-grading, autograding, self-grading, multiple attempts, accumulating grades
- Leaderboards: Grades, top likes, top activity,..
- Social dimension: single player, multi-player (community), choice, friends only, … cohorts (grouping students e.g. by hand-in time)
- "Living" spaces (scope): Global (Forum), Team (Journal, blog, ..), Personal (Journal, Blog....) , Private
- Communication features: Life chat, forum (asynchronous), likes, ratings, comments,
- Learning path: multiple, single, dynamic, static
- Progressive platform view: onboarding, scaffolding of platform functionality, elder role

3.2 Functionalities according to Learner type

Learner types listed in Section 2.1 are used as stereotypes for the purpose of this work. In this sense, we can define a simple prototypical but different use of the platform for each of the stereotypes along the dimensionalities described in Section 3.1. Tables 2-7 define the functionalities according to the learner type characteristics. The highlighted parts are especially important to that learner type. The functionality listed is taken from Appendix A. For example "Simple Platform View" relates to the dimension of Progressive Platform View and is important to the "Avoidant" user who likes to keep it simple. "Benefits from Forum" relates to the Communication Dimension. In this sense, these tables do not depict derived characteristics but definitions to describe stereotypical dimensionality of the hypothetical learner type. The usefulness of these definitions will be verified only if they serve as an intermediary form of describing actual usage patterns by real students.

Table 2 shows the functions that we define as important for the avoidant learner. This stereotype is different from others as the goal is to manage the course with as little effort as possible. A passing grade is the goal. All has to be kept as simple and clear as possible. Team based effort is essential.

Table 2: Important Features for Avoidant Learner.

	Function (important in bold)
Avoidant: "Keep it simple, passing is everything!"	**Simple Platform View**
	Lots of support for using platform
	Benefits from Forum
	Benefits from publicly posted Homework
	Wants to keep an overview of current grade to make sure it is a passing grade.
	Likes to know how much work is left
	Prefers multiple attempts in an online exam
	Team projects are essential for survival
	Team grading is essential
	Teacher should provide clear learning path that does not change dynamically
	Benefits from peers' work
	All course content should be easy to find and clearly marked as necessary.

Table 3 shows the functions that we define to be important to a collaborative learner. That stereotype

is defined by the wish to work in a community. Synchronous learning is more important than independent learning. Grades are important. Work load and a good chance at a good grade through formative grading are relevant. Simple is good here as well. The prototypical collaborative learner is not interested in individual grades and projects.

Table 3: Important Features for Collaborative Learner.

	Function (important in bold)
Collaborative: "I can do it in a team!"	**Synchronous learning**
	Lots of support for using platform
	Forum and team blog and journal, team-based todo list
	Share Homework
	View current grade
	Peer evaluation
	Likes to know how much work is left
	Prefers multiple attempts in an online exam
	Formative grading
	Team grading
	Choose my own team
	Classroom interaction and peer content
	All course content and Dashboard with news

Table 4 shows the functions that we define as important to the competitive learner. The stereotype is defined by the wish to be the best. Leaderboards, likes, badges, grades, view of class performance are very important. Multiple attempts in exams serve the purpose to gain full points on an exam. This person wants to see all the information on the system – progressive unlocks would hinder the performance. Team work and projects can slow this person down. Asynchronous learning is important so that this learner can move on to the peer group at the next level when ready (as in sports or games) and not be stuck with the same cohort (like the traditional classroom setting).

Table 4: Important Features for Competitive Learner.

	Function (important in bold)
Competitive: " Challenge me!"	Synchronous/asynchronous learning ok
	Doesn't need or even want progressive unlocks
	Team & personal blog
	Leaderboards
	Grades and Class-performance
	Achievements
	Top Likes, Ratings, Activities
	Homework with peer and self-evaluation
	Multiple attempts in exams
	Formative Grading
	Likes, Ratings
	Comments on homework
	Self-made dynamic content
	Course overview and static content

Table 5 shows the functions that we define as important to the independent learner. The stereotype is defined by the wish to work alone. Asynchronous learning is important. Individual projects are essential. This learner type prefers to create their own learning path and not just rely on the teacher.

Table 5: Important Features for Independent Learner.

	Function (important in bold)
Independent: "I am working by myself"	Choosing own speed of learning
	Progressive unlocks or **give me everything from the start**
	Grades
	Improvement with respect to self
	How much work is left
	Homework
	Multiple attempts and formative grading
	Individual grade
	Individual study
	Self-chosen team
	Individual projects
	Comments on work
	Multiple learning paths according to own needs
	Self- and peer made content
	Extra helpful information

Table 6 shows the functions we define as important to the dependent learner. This person needs strong guidance. Flexible learning path or changes in content are not appreciated. Teamwork is preferred over individual work. Synchronous learning, defined, regular homework is important. Grade overview is helpful. Course content has to be easy to find and clearly structured.

Table 6: Important Features for Dependent Learner.

	Function (important in bold)
Dependent: "I'll never make it on my own!"	**Synchronous learning**
	Very simple view of platform
	Team blog, Team-based todo list
	Team-based
	Grades to see if they are surviving
	How much work is left
	Homework based grading
	Multiple attempts in exam, formative grading
	Team work
	Comments on work
	Single, well defined path
	Professional static content
	Course material easy to locate

Table 7: Important Features for Participant Learner.

	Function (important in bold)
Participant: "I'm really interested!"	Mix of synchronous/asynchronous learning
	Forum, blogs, journals
	Sharing of homework
	Grades
	How much work is left
	Homework based grading
	Multiple attempts in exam, formative grading
	Mix of individual/team work
	Comments on work and ratings
	Ratings, likes
	Classroom interaction
	Self-made, peer-made and professional content

Table 7 shows the functions that we define as important for the stereotype of the participant learner. This person will be open to try out various functions. None are of particular importance, but all can be tested. If the teacher recommends the function then this person will try out how to integrate it into their study.

Student responses were collected via Surveymonkey and the Likert scales were weighted with the various user types to display student profiles. Results from the survey are presented in the next section.

4 SURVEY RESULTS

For each of the functions listed in Appendix A, 77 students' responses on the 4-point Likert scale from "totally irrelevant" to "very important" were collected.

4.1 Learner Type Vector

For each of the learner types a weighting vector was created for the functions and the dot product with the responses collected. This resulted in a vector of length 7 denoting a mix of learner types that can then present the foundation for categorizing students accordingly. The calculation is given in Equation 1:

$$S[t] = \frac{\sum_{i=1}^{n} L[student][i] * W[t][i]}{\sum_{i=1}^{n} abs(W[t][i])} \quad (1)$$

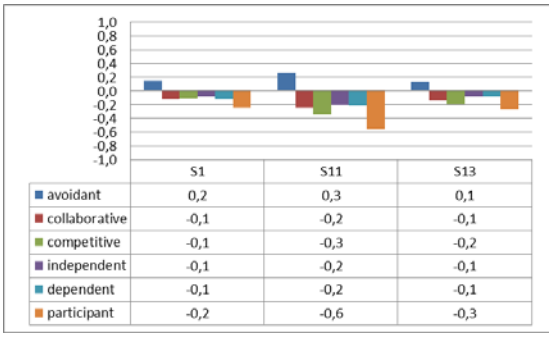
Here, t is the learner type, n is the number of functions evaluated (i corresponds to the question #), L is the Likert scale from 0..4 ("totally irrelevant"…"very important"), W is the weighted vector of how important a functionality is for a particular stereotype, with values 0 (not relevant,-1 (not important), 1 (important), and 2 (very important). Each student response is then represented by the vector $\vec{S}$ of length 7, where the average over all students for each element is subtracted from Equation 1 as shown in Equation 2 to focus on the difference.

$$S[t] - \overline{S[t]} \quad (2)$$

The results are then plotted for each student and compared by inspection.

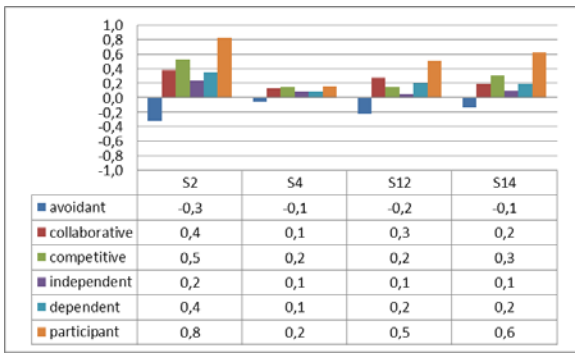
4.2 Student Vector-Groups

It can be seen by inspection that certain vectors $\vec{S}$ look similar across students. Figure 1shows some of these for 14 sample student vectors.



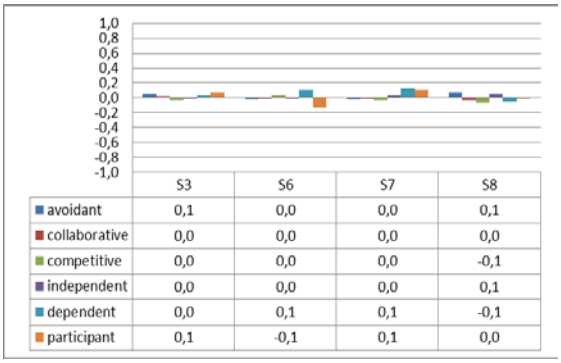
	S1	S11	S13
avoidant	0,2	0,3	0,1
collaborative	-0,1	-0,2	-0,1
competitive	-0,1	-0,3	-0,2
independent	-0,1	-0,2	-0,1
dependent	-0,1	-0,2	-0,1
participant	-0,2	-0,6	-0,3

Figure 1: Vector *S* for student S1, S11, S13: more avoidant than average, less than average on other characteristics



	S2	S4	S12	S14
avoidant	-0,3	-0,1	-0,2	-0,1
collaborative	0,4	0,1	0,3	0,2
competitive	0,5	0,2	0,2	0,3
independent	0,2	0,1	0,1	0,1
dependent	0,4	0,1	0,2	0,2
participant	0,8	0,2	0,5	0,6

Figure 2: Vector *S* for students S2, S4, S12 and S14: less avoidant than average, more than average on other characteristics



	S3	S6	S7	S8
avoidant	0,1	0,0	0,0	0,1
collaborative	0,0	0,0	0,0	0,0
competitive	0,0	0,0	0,0	-0,1
independent	0,0	0,0	0,0	0,1
dependent	0,0	0,1	0,1	-0,1
participant	0,1	-0,1	0,1	0,0

Figure 3: Vector *S* for student S3, S5, S7, and S8: average students.

Similarities between different student vectors can be noted. Comparing S1, S11 and S13, it can be seen

that the basic pattern, with different magnitudes shows a learner type that is more avoidant than average and classifies less than average as any of the other types, especially concerning collaboration, competitiveness and participation. In contrast, S2, S4, S12, and S14 are less avoidant than average (to different degrees) and stronger than average on collaboration, competitiveness and participant characteristics. S3, S6, S7, and S8 show average profiles. Going through the data by inspection, the following patterns can be found:

- 0: Average (12)
- PC: Participant and Collaborative (4)
- PCA: Participant, Collaborative, Avoidant (1)
- PC-A: Participant, Collaborative and not Avoidant (14)
- PC-I: Participant, Collaborative and not Independent (1)
- CompP-A: Competitive, Participant and not Avoidant. (8)
- A: Avoidant (4)
- Ax-P: Very Avoidant and not Participant (12)
- I-D: Independent and not Dependent (1)
- A-PC: Avoidant and not Participant and not Collaborative (11)
- A-CompP: Avoidant and not Competitive and not Participant (2)
- 0-PC: Not Participant and not Collaborative (2)
- P: Participant (1)
- 0-AI: Not avoidant and not independent (1)
- D-P: Dependent and not Participant (1)
- DP: Dependent and Participant (1)
- Minus-all: All score low (1)

Maintaining Grasha's nomenclature according to the most pronounced stereotype in a pattern, categories can be collapsed into **Avoidant** (A,Ax-P, A-PC, A-CompP), **Participant&Collaborative** (PC, PCA, PC-A, PC-I, P, DP), **Competitive** (CompP-A) and Average (0), the pie chart in Figure 2 shows the fragmented, yet categorized distribution of the student body.

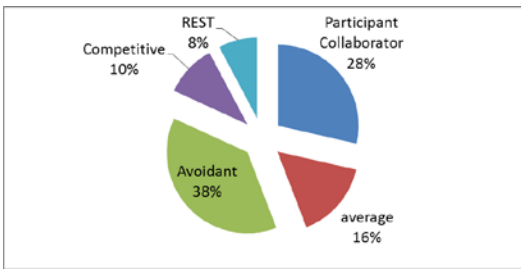


Figure 4: Fragmented Student Body.

4.3 Platform Requirements

Stereotyping the platform most coveted by each of the larger groups of students, it can be seen in Table 8 that the functionalities are quite different.

Table 8: Important Features for Main Learner Groups as shown in Figure 2.

Functionality	**Avoid.**	**Part.Coll.**	**Competitive**
Time Dimension	synchr.	synchr.	asynchr.
Progressive View	simple		all
Living Space		team view	
Progress Overview	grades	grades	Point, Badges, Levels
Grading Dimension	team	team, peer-grading	individual, leaderboards
Social Dimension	team	Self-chosen team	individual
Communication		forum	likes, ratings
Learning Path	simple	adaptive	open
Content Dimension	given	peer	self, peer

Clearly, with a fragmented student body as shown above, a platform would have to be configurable in at least three diagonally opposed ways for **Avoiders**, **Competitors** and **Participant Collaborator** groupings. However, compared to frontal lecture without any flexibility, technology that is configurable by the student may provide more opportunity to render learner dependent views in the same classroom.

5 PROFILES VS. PLATFORMS

Coursesites, which was chosen for this course, can also be used as a MOOC platform. There are a number of MOOC platforms in use currently and it is interesting to look at their functionalities given the current study. As MOOC platforms are all under development, it would be difficult to define how each provides functionality within the nine dimensions given in Appendix A. In addition, courses on these platforms have various ways in which they can be configured and designed. Still, there are some basic features that may or may not be available on particular platforms. NovoEd, EDX and Coursera are chosen examples of MOOC platforms because they represent some of the most popular platforms, in addition, Duolingo is an example of a popular freely available language learning platform. While NovoEd has the capability to provide team and personal "living spaces", EDX has the capability to show an excellent progress bar but difficulty with clear Forum spaces. While Coursera makes it easy,

according to student reports to find the learning path, EDX may feel a bit more difficult for onboarding. Table 9 indicates the current particularities of the platforms based on courses visited by the author in 2012. Only **distinguishing features** are listed to keep the table simple. Such particularities may influence which type of student would prefer a particular kind of platform. It is of interest to note, that none of the platforms allow the students to configure their own view.

Given the exemplary particularities as shown in Table 9, the **Avoidant** learner group will be more comfortable in a synchronous course with an easy view of the platform functionalities and content, team based effort and a clear view of the current grade. Such a student would need the simple view from Coursera, the grade progress view from EdX and the team based approach that NovoEd supports very strongly.

The group **Participant Collaborator** is probably best served with the NovoEd platform because it provides good collaborative spaces and enough information about the grades and progress to grant the basic overview needed by this group.

The **Competitive** group will find some of these platforms constraining in that they are mostly set up to be synchronous with single given path. A tool like Duolingo that allows choices of path and speed as well as leaderboard, points and badges may be more suitable. However, the team dimension is completely missing to support the competition aspect with others. This learner type will also not be served well by any one of these platforms yet.

Table 9: Features provided by MOOCs highlighting particularities.

MOOC	TD	PV	LS	PO	GD	SD	CF	LP	CD
Edx	s			y					
Coursera	s	s		p					
Novoed	s		f t i	p	i,t s		l, p		
Blackboard	s/a		t	p					
Moodle	s/a								
Duolingo	a	cU fU	i	y	a, p m			m	nl

Table 10: Key to Table 9.

TD: Time dimension: s=synchronous, a=asynchronous
PV: Progressive Platform View: s=simple, cA=content all, cU=content unlock fA=features all, fU=features unlock
LS: Living Space: n=none, f=forum, t=team, p=personal
PO: Progress Overview: y=yes, n=no, p=partial
GD: Grading Dimension: n=none, a=automated, s=self, p=peer; i=individual, t=team; m=multiple attempts, 1=single attempt
SD: Social Dimension: i=individual, t=team, m=mixed, a=all
CF: Communication Features: f=forum, ch=chat, m=messaging, cc=teacher comments on work, l=leaderboard projects, p=personal interactions
LP: Learning Path: s=single, m=multiple, d=dynamic
CD: Content Dimension: s=self made, p=peer made, t=teacher made, d=dashboard, x=extra info, nl=no lessons

While the match between student learner types and platform offerings has not been done in a quantitative manner, the discussion serves as input to understanding student retention and how platforms can cater to various needs.

6 DISCUSSION

In this paper, it was shown that student population can be grouped by learner-type vectors that are related to functionalities on learning platforms, which have been grouped into a nine dimensional feature space. We use Grasha's theoretical definition of six learner-stereotypes to define an exaggerated usage pattern for each. While students do not match these stereotypes, usage patterns become evident in the degree to which they match a combination of these pure definitions. As learners are not stereotypical, such vectors are a better means of grouping students. It was shown that such grouping is possible and that opposing dimensions of functionalities are required for different user groups. This finding, hereby quantified, can have a direct consequence on understanding how well students are able to learn in different environments, virtual or real. Will environments need to be specialized or adaptive to enable optimal learning for each student? Further work is required to refine understanding of these groupings and define user-based views for a single course offering. Open questions are whether platforms should cater to particular learner types? How does this affect teaching in the classroom at University where classes are usually not split by learner types? Splitting classroom by types would make life for the Avoidant type quite difficult. Some research will have to go into how to provide different front ends to the same material.

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APPENDIX A

The following table lists all functionalities according to the 9 questions from Section 2.2 on which the student survey is based.

Time Dimension
TD: Synchronous learning
TD: Asynchronous learning
TD: Mixed style
TD: Choosing your own speed of learning
Progressive Platform View
PV: A very simple view in the beginning that opens up progressively
PV: A lot of support with the platform in the beginning
PV: Gaining more rights as I work more with the platform
PV: Give me everything from the start – I can handle it
Living Spaces
LS: Forum for all (public)
LS: Team blog (public)
LS: Personal blog (public)
LS: Team journal (private to team)
LS: Personal journal (private to me)
LS: Sharing homework hand-ins for others to see
LS: Team-based Todo Lists
Progress Overview
PO: Leaderboard (Points)
PO: My Grades (overview)
PO: Average Grade in class
PO: improvement wrt. self
PO: Achievements (badges)
PO: Top Likes
PO: Top Activity
PO: how much work is left
Grading Dimension
GD: Forum entries
GD: "likes" of your contributions by others
GD: Homework
GD: Peer evaluation
GD: Self evaluation
GD: Multiple Attempts in evaluation
GD: Accumulated formative grading
GD: team based grade
GD: individual grade
GD: mix of team/individual grade
Social Dimension
SD: Study on your own
SD: Study in community
SD: study in self chosen team
SD: study in random team
SD: change choice of who you study with
SD :team projects
SD: individual projects
SD: mixed team/ind. Work
Communication Features
CF: Life Chat
CF: Forum (asynchronous)
CF: Likes (cool)
CF: Ratings (1-5)
CF: Comments on your work
CF: Leaderboards
CF: Classroom interaction – person2person
CF: Team meetings when you decide (rather than in class with teacher present)
Learning Path
LP: Choice of multiple learning paths to choose from according to my own needs and preferences
LP: A single, well defined path prescribed by the instructor
LP: A path that changes depending on my needs or progress
LP: A static path so that you have a defined amount to learn and a defined end in time to the learning
LP: Personal Todo Lists
Content Dimension
CD : Self-made content
CD: Peer-made content
CD: Professional content
CD: Static content
CD: Dynamic content
CD: Syllabus/Course Introduction
CD: Info about teacher
CD: Home-page/Dashboard with News, Updates…
CD: Course content (slides, assignments, test)
CD: Extra Information (going beyond class material)