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Abstract

We investigate incentive mechanisms to increase active participation in Learning Networks. The Learning Network under study is LN4LD, a Learning Network for the exchange of information about the IMS Learning Design specification. We examine how to encourage learners in LN4LD to contribute their knowledge, and whether *incentive mechanisms* can increase the level of active participation. We describe an incentive mechanism based on constructivist principles and Social Exchange Theory, and experimentation using the mechanism designed to increase the level of active participation. The incentive mechanism allows individual learners to gain personal access to additional information through the accumulation of points earned by making contributions. Repeated measurements according to a simple interrupted time series with removal design show that the level of participation was indeed increased by the introduction of the reward system. It can therefore be considered worthwhile to use incentive mechanisms in Learning Networks.

Informed participation for community-based learning and design

Recent research, inspired by constructivist principles, views the quality of the learning process as being improved by the *active participation* of learners, whereby learners move from a passive role as information consumers to a more active one in which contributions are made, reviewed, rated, improved, and so on. Gerhard Fischer of the Center for Lifelong Learning and Design at the University of Colorado in Boulder has, over a number of years, investigated IT-support in helping learners progress from consumers ("couch potatoes") to active participants (see e.g., Fischer, 2001). Fischer and Ostwald (2002) more recently referred to this work as encouraging "informed participation":

> "Informed participation is an approach for community-based learning and design in which all participants actively contribute toward the framing and solving of complex and multidisciplinary problems. Informed participants go beyond the information given to explore large problem spaces, learn from their peers, and create new understandings. Informed participation requires social changes as well as new interactive systems that provide the opportunity and resources for social debate and discussion rather than merely delivering pre-digested information to participants."

In addition to improvements in the quality of the learning process, the mutual exchange of information by large numbers of individual learners offers some hope of a solution to the 'teacher bandwidth' problem encountered in online learning (Wiley & Edwards, 2002). We refer to a group of persons who create, share, support and study in a specific knowledge domain as a Learning Network or LN (Koper & Sloep 2003; Koper et al, in press). Inherent in the notion of an LN is the continuous commitment of learners to not only acquire but also actively contribute knowledge. In addition to solving the cold-start problem ('we built it but

no one came'), the problem of too large a majority coming but just 'lurking' needs to be tackled in Learning Networks (e.g., Nonnecke & Preece, 2001).

The factors and incentive mechanisms that motivate people to codify and share knowledge for the benefit of others have been identified as a priority area for individual companies (Smith & Farquhar, 2000). They represent the most commonly discussed topic amongst practitioners and academics at conferences on knowledge management (Prusak, 1999). To some, the encouragement of employees to contribute knowledge is even more important than the more technical (interoperability) issues related to its capture, storage and dissemination (e.g., Boisot & Griffiths, 1999).

Can we assume that simply by providing the right infrastructure Learning Networks will emerge or should we look to stimulate this process in some way? What might then motivate an individual to participate actively in a Learning Network, to respond to others' questions, to contribute content, complete activities, carry out assessments? This study investigates a Learning Network concerning the IMS Learning Design (LD, 2003) specification, known as LN4LD, designed to encourage learners to contribute their knowledge. In particular we investigate whether *incentive mechanisms* increase the level of active participation in Learning Networks. Before we turn to our method and the results of our experimentation, we first discuss a theoretical framework that motivates the design of incentive mechanisms to increase contribution and decrease lurking.

Social Exchange Theory

Social Exchange Theory provides a theoretical framework with guidelines to increase active contribution and decrease lurking. This theory (e.g., Thibaut & Kelly, 1959; Constant et al., 1994), derived from economics' rational choice theory, suggests that there is a relationship between a person's effect (satisfaction with a relationship, i.e. LN) and his

commitment to that relationship, i.e. his willingness to contribute knowledge to the LN.

Social Exchange Theory argues that individuals evaluate alternative courses of action so that

they get best value at lowest cost from any transaction completed.

The social exchange literature (e.g., Davenport & Prusak, 1998; Tiwana, & Bush, 2000;

Butler et al, 2002; Lui, Lang & Kwok, 2002; Vassileva, 2002; Obreiter & Nimis, 2003)

suggests four main incentive mechanisms to motivate and encourage community members (in

our case, learners) to participate: (1) *personal access*, or anticipated reciprocity: learner has a

pre-existing expectation that he will receive actionable and useful (extra) information in

return; (2) *personal reputation*: learner feels he can improve his visibility and influence to

others in the network, e.g. leading to more work or status in the future; (3) *social altruism*:

learner perceives the efficacy of the LN in sharing knowledge as a 'public good', especially

when contributions are seen as important, relevant, and related to outcomes; (4) *tangible*

rewards: learners negotiate to get some kind of more tangible asset (financial reward, bond,

book, etc) in return. Other distinctions have been made between: individual (access,

reputation, reward) versus interpersonal factors (altruism) (Deci, 1975; Deci & Ryan, 1985);

hard (e.g., access, money) versus soft (e.g., satisfaction, altruism) rewards (Hall, 2001);

quantitative versus qualitative gain, intrinsic versus extrinsic factors, and others.

Researchers warn against the backlash of introducing tangible rewards as incentive

mechanisms, since they might destroy the 'public good' thought (e.g., McLure Wasko &

Faraj, 2000). A public good is a commodity that can be provided only if group members

contribute something towards its provision; however all members may use it (Komorita &

Parks, 1995). Greater self-interest reduces knowledge sharing (Constant et al., 1994) and

people are less likely to use collaborative technologies to share information perceived to be

owned by an organization (Jarvenpaa & Staples, 2000). Introducing tangible rewards in return

for the provision of public goods promotes self-interested behaviour, reduces intrinsic

motivation, and destroys the public good. The danger is that individuals may appear to be contributing something, but what is not contributed is more significant. This would appear to be more significant when tangible reward mechanisms are in operation (Leonard & Sensiper, 1998; Von Krogh, 1998). When knowledge is considered a public good, knowledge exchange is motivated by moral obligation and community interest (altruism) rather than by narrow self-interest (access, reputation, rewards).

In each of the above cases, incentive mechanisms for knowledge sharing should match the spirit of what has to be achieved (Sawyer et al., 2000). If this is finding and exchanging information about LD, research suggests that incentives to gain extra personal access to more information about LD can be expected to render best results.

Method

In order to investigate whether incentive mechanisms increase levels of active participation in Learning Networks, a pilot study was carried out in the authentic context of the EC-funded UNFOLD project (see http://www.unfold-project.net). UNFOLD aims to bridge information gaps for those interested in understanding, using and implementing the LD specification. The specification was approved in early 2003 and it has taken some time to develop tools and players; UNFOLD aims to accelerate this process.

An initial pilot had been carried out with about twenty colleagues from our own research laboratory using Groove to exchange information on a variety of topics related to LN (Koper et al, in press). LN4LD can thus be considered a second pilot, aiming to validate parts the architectural model depicted in Figure 1 with larger numbers of learners.

Figure 1. Part of the architectural model for LN (UML-class diagram)

First experiences when setting up this Learning Network before the period of experimentation described in this paper have been reported by Hummel et al. (in press). This second and subsequent pilots are now being set up to collect and compare data on LN dynamics in a more effective and (experimentally) controlled way.

The architectural infrastructure for LN4LD was created with two aims: a. to ensure that the general architectural model could be implemented; and b. to examine whether the resulting LN met requirements for the exchange of information (Müller, Spiliopoulou & Lenz, 2001; Koper et al , 2004). According to the architecture, three layers of implementation are required: a general portal giving access to various LNs; an LN giving access to several so-called Activity Nodes, or ANs, which may contain any information that leads to learning (e.g., a course, a resource, an online chat, a quiz); and a layer containing the actual ANs. The portal and LN layer were implemented using the Plone platform (Limi, 2005); the AN layer was implemented using Moodle (Dougiamas, 2004), and contained specific courses for those interested in LD as learning designers. See figure 2 for a graphical illustration of this set-up. This study examined participation within the AN layer, modelled in Moodle.
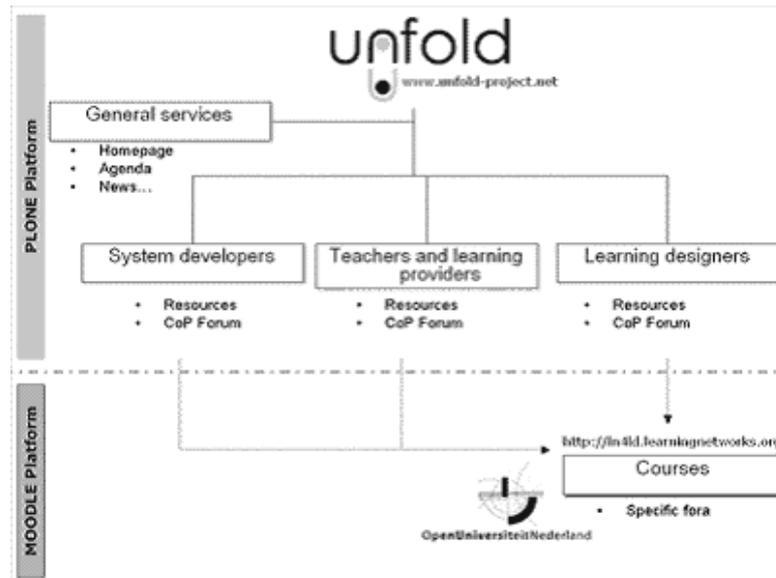
Figure 2. General set-up of the UNFOLD Communities of Practice

Participants

The sample used for this study consisted of 125 individuals who enrolled and accessed the Learning Network during the experimental period. Seventeen countries were represented as the origin of participants. A large portion came from countries represented by UNFOLD Project Partners: The Netherlands, United Kingdom and Spain. Other significant groups came from elsewhere in Europe and North America.

Learning material

We 'seeded' the Learning Network with an initial set of five ANs about the LD specification (for the concept of 'courses as seeds' see De Paula, Fisher, & Ostwald, 2001; De Paula, 2003). All ANs provide assignments, resources and a forum around a more specific LD-related topic. The titles for these topics were 'Getting started with the IMS LD specification', 'Understanding basics of IMS Learning Design', 'How to modify Units of Learning', 'Experience running Units of Learning', and 'IMS Learning Design and Metadat'.

Access to another AN, called 'Running examples of Units of Learning' was restricted as a reward for participants passing a certain threshold during experimentation. This AN offered concrete instructions to see actual Units of Learning, modelled in LD, in action. The

CopperCore engine (Vogten & Martens, 2004), which allows the examples to be played, had just been released shortly before experimentation, and this preview was not yet available to others in the community. We therefore considered extra access to this restricted AN to be a real incentive for those eagerly awaiting to see LD in action. All examples contained a content package (CP, 2003) to be run with CopperCore and instructions for instantiating the run of the course, together with complementary explanations of the Unit of Learning in writing or as a visual presentation. Most examples contained a detailed description of the narrative of the learning design and a step-by-step walkthrough with explanatory screenshots. The titles for the five Units of Learning were 'Hello World', 'Simple Learning Activity', 'Candidas: The great Unknown', 'Learning activities with conditions' and 'What is greatness?'.

Experimental design and procedure

A simple interrupted time series with removal design (see e.g., Robson, 2003) was applied with (active and passive) participation as the independent variable. Although the main research aim of this experiment was to measure the hypothesized increase in active participation, we also monitored data on passive participation. Both types of participation contribute to the collective behaviour of the Learning Network, and were considered worthwhile to be studied.

Participants ($n = 125$) were informed before experimentation that LN4LD would be used for experimental purposes in addition to its educative role. Upon introduction of the incentive mechanism, the participants received further instructions on the use and benefits of the incentive mechanism. In line with the use of a simple interrupted time series design with removal, the experimental period consisted of three equal periods, in our case with a duration of 4 weeks each: the first time interval served for a baseline measurement (period A), the second time interval was intended to measure the effects of introducing the incentive mechanism (period B), and the third interval was intended to measure the sustainability of the

effects after removing the mechanism (period C). Data on both active and passive

participation (page views) were logged during the experiment. However, the focus of this

study was on increasing the level of *active* participation by introducing an incentive.

The mechanism allowed participants to earn points for contributions, with the reward

scheme including both quantitative and qualitative components. On the quantitative side,

points could be earned for (A) forum postings (20 points for each, labelled 'pontsforpost');

(B) replying to posts (10 points for each, labelled 'pointsforreply'); and (C) rating of posts (3

points for each, labelled 'pointsforrate'). With respect to the quality of postings, contributors

received additional points: (D) each time their contribution prompted a reply (5 points for

each reply to a post, labelled 'pointsforreplyrec'); and (E) each time the originator's posting

was rated (3 points * rating value, labelled 'pointsforraterec'), whereby the ratings ranged

from 1 (very poor) to 5 (very good). At the start of the intervention period, participants were

informed about the mechanism and the five parameters (A to E). They were told that the total

amount of points earned on all five parameters needed to exceed a threshold limit of 33 points

to obtain the reward, i.e. in order to gain personal extra access to the restricted Moodle course

containing the running examples of Units of Learning. The threshold was kept low

deliberately; with just one post, one reply and one rating the extra access would already be

granted. The amount of points earned by each participant was made visible through an extra

module in Moodle. Administrators could see the points earned by every participant on every

parameter; participants could just see their overall amount of points.

Results

Repeated measures ANOVA was applied on the total amount of points for active

participation, using time of measurement (period A: before intervention; period B: during

intervention; and period C: after intervention) as a within-subjects factor and type of

participation (either 'those who did not score' or 'those who did score') as a between-subjects factor. The partial-eta-squared statistic was used as an effect size index where values of .01, .06, and .14 correspond to small, medium, and large values, respectively (Cohen, 1988). Additionally, we applied paired t-tests for comparisons between periods A and B, and between periods B and C (both one-tailed). Furthermore, some basic descriptive statistics and various graphs were distilled on the five parameters (indicators of active participation), and on the amount of page views (indicator of passive participation), to provide information on participation during experimentation.

Active participation

First of all, we should note that from the total population (n = 125) only a relatively small group of participants (n = 17) actually scored any points at all (i.e., earned points for making contributions) during experimentation. This percentage of 13.6 % is relatively small, and even smaller than average percentages of around 25% reported for most asynchronous groups (e.g., Nonnecke & Preece, 2001). Of the 17 participants who earned at least one point, 12 earned enough points to pass the threshold and gain access to the reward. Data on active participation are consequently heavily skewed and the averages low; we therefore will report these data by making a distinction between all participants and the active participants only. We start by presenting some descriptive data, before discussing the statistical differences over time.

The peak of active participation was logged during the first day of period B, immediately following the introduction of the incentive mechanism and we also note here that more active participation was recorded during period C than period A. A total of 824 points for active participation were logged during experimentation, leading to an average of 6.6 points per participant (*n* = 125). Tables 1A and 1B present the totals and averages for each period on each parameter of active participation, for all participants (n = 125) and for those who were active (i.e. scored at least one point, n = 17).

Points X Period	Total points	Points forpost	Points forreply	Points Forrate	Points forreplyrec	Points forraterec
A. All	117	60	20	3	10	24
B. All	566	220	120	42	100	84
C. All	141	40	30	12	35	24
A-C. All	824	320	170	57	145	132

Table 1A. *Total active participation points for each period and for each parameter,*

for all participants (n=125)

Averages X Period	Avg. Total points		Avg. Points forpost		Avg. Points forreply		Avg. Points Forrate		Avg. Points forreplyrec		Avg. Points forraterec	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
A. All	.94	5.92	.48	3.07	.16	1.80	.02	.27	.08	.63	.19	1.31
A. Active	6.88	15.10	3.53	7.86	1.18	4.85	.18	.73	.59	1.66	1.41	3.37
B. All	4.53	16.27	1.76	6.73	.96	4.10	.34	2.02	.80	3.61	.67	3.38
B. Active	33.29	32.16	12.94	14.04	7.06	9.20	2.47	5.11	5.88	8.34	4.94	8.14
C. All	1.13	9.50	.32	3.58	.24	2.00	.10	1.07	.28	2.72	.19	1.46
C. Active	8.29	25.22	2.35	9.70	1.76	5.29	.71	2.91	2.06	7.30	1.41	3.84
A-C. All	6.60	11.49	2.56	4.77	1.36	2.84	.46	1.33	1.16	2.65	1.06	2.26
A-C. Active	48.47	31.86	18.82	13.17	10.0	10.0	3.35	5.50	8.53	9.64	7.76	9.00

Table 1B. *Average active participation points, expressed as averaged totals for each period*

and on each parameter, both for all participants (All; n=125) and for the group of active

participants (Active; n=17)

Table 1A shows that most active participation points were earned by making postings to

forums (320 points in total, with 220 of these being in period B). Over time, the total amount

of active participation points was divided as follows: 117 points in period A, 566 points in

period B, and 141 points in period C. Table 1B shows that the average total points for active

participation earned by active participants (n = 17) is 48.47 and by all participants (n = 125) it is 6.6. Visual inspection of the descriptive data clearly points to a substantial increase during period B, the period the incentive mechanism was in operation. Additionally, Table 2 reveals that, of the group of 17 active participants, 7 participants (grey cells) reached the threshold during period B, and were granted access to the 'reward'; two participants had already earned sufficient points prior to the introduction of the incentive mechanism, and three participants earned enough points in period C.

USERID	TOTAL POINTS PER PERIOD		
	A	B	C
28	37	3	0
30	31	0	3
32	46	15	0
33	0	47	30
35	0	31	6
48	0	3	0
54	0	62	0
55	0	100	0
69	0	75	0
72	0	79	0
150	3	0	0
160	0	15	0
175	0	61	0
180	0	0	102
186	0	10	0
195	0	25	0
202	0	40	0

Table 2. *Active users (n = 17) who scored and users (grey) who reached the threshold*

Figures 3, 4 and 5 provide graphical information about the distribution of active participation points over the five parameters, and over the three periods of experimentation, respectively.
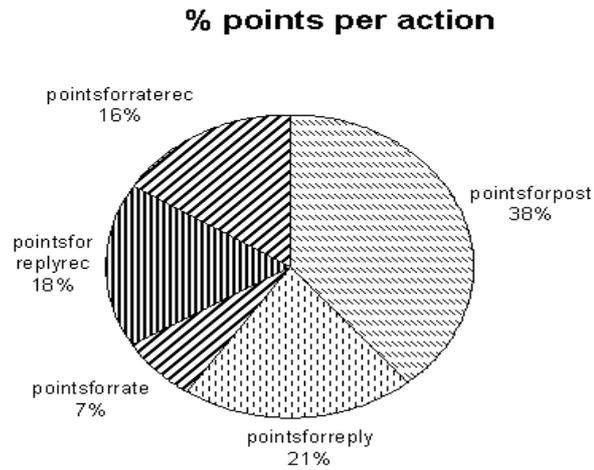
% points per action

pointsforraterec
16%

pointsfor
replyrec
18%

pointsforrate
7%

pointsforreply
21%

pointsforpost
38%

Figure 3. Distribution of total points for active participation over parameters

Points per action and period
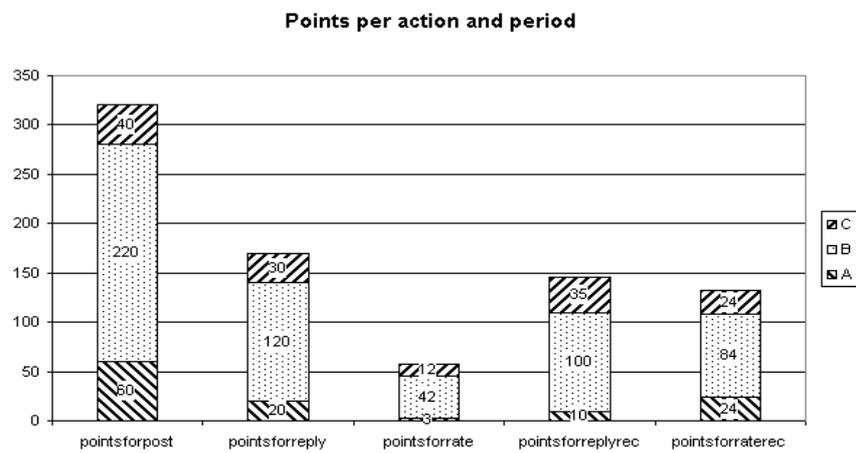
Figure 4. Distribution of points for active participation per parameter and period
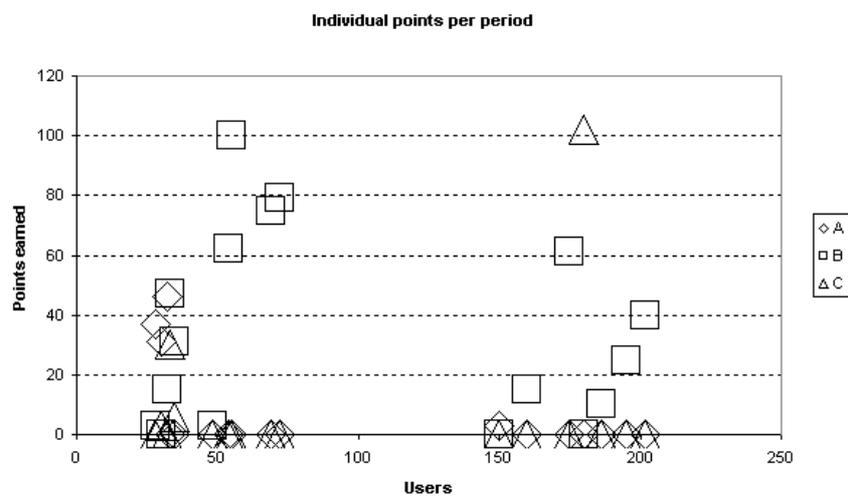
Individual points per period

Figure 5. Distribution of individual points for active participation per period

Descriptive data and visual inspection of the active participation data indicate a substantial increase after introducing the incentive mechanism, but can this impression be confirmed by statistically significant differences? The main indicator for the level of active participation in the network is the average total amount of points for all participants in a certain period. The repeated measures ANOVA, using time of measurement for the three periods as a within-subjects factor, reveals that 'period' indeed is a very significant factor in explaining the average total amount of points ($F (2, 122) = 14.17$, $MSE = 24,966.08$, $p < .001$, $\eta_p^2 = .104$), even with the majority of participants not actively contributing. Obviously, when we include 'scoring' (either 'those who did not score' or 'those who did score') as a between-subjects factor, (period * scoring) appears to be an even more significant factor ($F (2, 122) = 31.21$, $MSE = 24,966.08$, $p < .001$, $\eta_p^2 = .204$) in the linear model.

Paired t-test comparisons for all participants also reveal differences between periods, again even with the majority of participants not actively contributing. The differences for the total amount of points for active participation between periods A and B ($t (124) = -2.34$, $p = .01$, one-tailed) and between periods B and C ($t (124) = 2.06$, $p = .02$, one-tailed) both appear highly significant.

Since only a relatively small portion of the participants accounted for active participation (skewed distribution of active participation points over the sample), parametrical tests may result in over conservative estimates. Therefore, we also carried out some non-parametrical tests on the differences found between related groups (same participant in periods A and B). Differences for these related groups (all with $n = 125$, and p one-tailed) between periods A and B on the total amount of points for active participation could be confirmed both by Friedman's median test ($X^2 = 11.04$, $p < .001$), and by Kendall's W ($W = .004$, $p < .001$). Wilcoxon's signed ranks test also revealed different medians and distributions between periods A and B ($Z = -2.25$, $p < .05$) and between periods B and C ($Z = -2.58$, $p < .01$).

Passive participation

During the three periods, passive participation by the participants was also logged, focusing on visits to Moodle functionality including assignments, courses, forums, quizzes, resources, users and to the personal scorecard. This kind of activity has been described as 'lurking', or using the network without making any valuable contribution to others. Figure 6 gives a graphical impression of the distribution of the total passive participation points over the three periods. Table 3 provides an overview of these page views for all periods, as well as the averages per day and per user during the periods.

Of the 125 participants in our study, 82 visited and used the Learning Network during the experimental period. Table 3 shows period B as having twice as many visits as both other periods. A total of 3,767 'passive actions' were logged (again with a majority of 2,283 during period B). Visits are most frequent to courses (1,508) and forums (1,003), accounting for 66.66%, while visits to resources (592) and the pages representing other users (403) account for 26.41% of the overall passive participation. Average passive participation per day was 41.50 page views in period A, 95.13 in period B, and 35.65 in period C. Curiously, the average passive participation per user decreased in period C when compared to period A. While there were more passive users during period C, there was less activity per user. During period A there were fewer passive users but more activity per user.
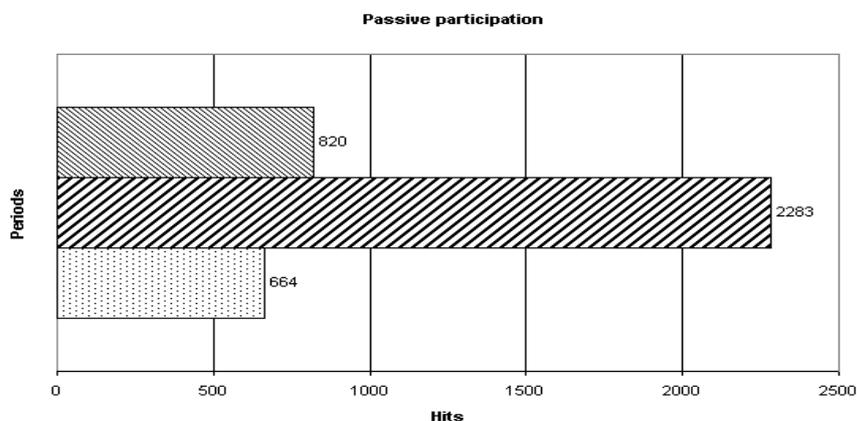

Figure 6. Passive participation points per period

Visits x period		all visits	assign ment	course	forum	quiz	resource	user	score card
A	Total	664	1	294	103	46	123	92	5
	Avg / day	41.50	.06	18.38	6.44	2.88	7.69	5.75	.31
	Avg / user	5.23	.01	2.3	.81	.36	.97	.72	.04
B	Total	2283	51	896	626	78	372	203	57
	Avg / day	95.13	2.13	37.33	26.08	3.25	15.50	8.46	2.38
	Avg / user	17.98	.40	7.06	4.93	.61	2.93	1.60	.45
C	Total	820	1	318	274	9	97	108	13
	Avg / day	35.65	.04	13.83	11.91	.39	4.22	4.70	.57
	Avg / user	6.46	.01	2.50	2.16	.07	.76	.85	.10
A-C	Total	3767	53	1508	1003	133	592	403	75
	Avg / day	57.43	.74	23.18	14.81	2.17	9.13	6.30	1.08
	Avg / user	9.89	.14	3.96	2.63	.35	1.55	1.06	.20

Table 3. *Total passive participation points per period, with averages per day and per user (n = 125)*

Discussion

In this article, we have presented the results of experimentation on stimulating active participation in a Learning Network by introducing extra access to restricted information as an incentive mechanism. We used a simple interrupted time series design with removal experimenting with the LN4LD Learning Network, taking three consecutive periods of one month to monitor our participants, with the incentive mechanism only being available during the middle period. Results show indeed that encouraging participants with an incentive mechanism increased both active and passive participation on all the measurements. More

participants were stimulated to contribute to the network. Participants continued to contribute after the reward was withdrawn.

These results indicate that the choice for extra personal access as an incentive mechanism was in line with the general purpose of the Learning Network (getting more information), as indicated by Social Exchange Theory. Announcing extra access to specific information (running examples not yet available elsewhere) as a reward for participating actively triggered increases during experimentation.

 Although the results provide support for the hypothesis that incentive mechanisms encourage active participation, they do not *explain* the actual drives for participating in a Learning Network. We have not yet performed any kind of qualitative data collection on inner drives and motivation in participants that directly cause changes in behaviour (a 'glass box' approach). We have only analysed the quantitative outcomes of the intervention in the network, using a 'black box' approach. Inner drives depend on individual users and specific situations, and require qualitative techniques of investigation, e.g., by applying a diary method (Bolger, Davis, & Rafaeli, 2003) or blind interviewing techniques. The information ecological perspective (Guzdial, 1997) we adopted has proven useful in examining what happens, but has its weaknesses in explaining *why* things happen.

Other limitations of this study relate to the relative small group size of the community, and to the specific topic of study. Since participants came to the LN4LD community of their own free will and in the absence of any form of certification, similar results might not materialise for students entering a formal learning community. Replications of this study on a larger scale and for a larger variety of topics and target group are therefore warranted. In addition, experiments including other forms of intervention (e.g. face-to-face meetings) would allow us to collect more qualitative information on drivers for participation. Such an experimental set-up within the same community is currently being created and further articles

will report on the comparative effectiveness of the various approaches to encouraging

participation.

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