Education in the North

UNIVERSITY OF ABERDEEN

ARTICLE

Digital professional learning: triggers in an online badge-driven process

Sanna Brauer, Sanna.Brauer@oamk.fi
Senior Lecturer, Oulu University of Applied Sciences, Finland

Sanna Ruhalahti, sanna.ruhalahti@hamk.fi
HAMK University of Applied Sciences, School of Professional Teacher Education, Finland.

Ville Hallikainen, ville.hallikainen@luke.fi
Natural Resources Institute, Finland

DOI: https://doi.org/10.26203/2qhh-5k39

UArctic Thematic Networks

ARCTIC COUNCIL

Sustainable Development Working Group

Ministry for Foreign Affairs of Finland

To cite this article: BRAUER, S., RUHALAHTI, S., HALLIKAINEN, V., (2018). Digital professional learning: triggers in an online badge-driven process. *Education in the North,* **25**(1-2), pp. 64-86.

Digital professional learning: triggers in an online badge-driven process

Sanna Brauer, Sanna.Brauer@oamk.fi
Senior Lecturer, Oulu University of Applied Sciences, Finland

Sanna Ruhalahti, sanna.ruhalahti@hamk.fi
HAMK University of Applied Sciences, School of Professional Teacher Education, Finland.

Ville Hallikainen, ville.hallikainen@luke.fi
Natural Resources Institute, Finland

Abstract

Digital open badges describe in detail the expertise and professional competencies achieved in digital environments. “Learning Online” is a Finnish national professional development programme (PDP) of digital pedagogical competencies for vocational teachers. This study aims to identify the students who are particularly motivated by digital open badge-driven learning. The research question asks what triggers learning in such a badge-driven process. The data were collected in 2017 from in-service trained professional teachers and pre-service students (n = 329) of vocational teacher education who have earned digital open badges in a Learning Online PDP. A questionnaire was used to collect data, and a constrained correspondence analysis was conducted to analyse the data.

The theoretical approach focuses on the concepts of gamification, the triggers of online learning and the triggering effect of gamification in learning. The study is based on recognized variables affecting motivation in badge-driven learning: progressive challenges and the extent of required performance, enthusiasm for the badge-driven learning, study progress, inspiring gamification, option to study regardless of time and place and optional study paths. The results indicate differences and similarities in the experiences associated with achieved skill-set levels. The findings also suggest applying gamification and digital badging for the professional development of both pre- and in-service teachers; gamification motivates students, especially in the beginning of their studies. Furthermore, the results propose considering flexible study options that include customising studies and learning new and up-to-date competencies triggering digital open badge-driven learning.

Key Words: Motivation, Digital Open Badges, Digital Pedagogy, Professional Development, Constrained Correspondence Analysis

Introduction

Current methods of continuous professional development fail to inspire teachers to advance their own knowledge and skills continuously in working life (Kools and Stoll, 2016). The professional development of vocational teachers should include more than career growth related to their personal career paths or staff enrichment, both of which could be considered a singular form of intervention (Glatthorn, 1995). The Organisation for Economic Co-operation and Development (OECD) has created a survey known as the Teaching and Learning International Survey (TALIS, 2018). This survey assists countries in identifying challenges related to changes in educational paradigms while following the development of teachers' professional competences using various measures (Taajamo, Puhakka and Välijärvi, 2015). According to the results, the greatest challenges faced by Finnish teachers in developing their skills involve the use of information and communication technology (ICT). The great autonomy of Finnish teachers reflects a belief in their responsibility to enhance their own competences, yet tteachers rarely have a personal development plan; such a plan would focus on their specific training needs based on the competences required to implement a specific curriculum or set of degree requirements (OKM, 2016). The skills and knowledge acquired during the professional teacher training (60 ECTS credits for a teacher's qualification) are insufficient for a vocational teacher's entire career. This research focuses on these challenges in the context of Finnish professional teacher education.

To ensure teachers' continued professional development, their training should include a competence-development continuum supporting their growth (Mahlamäki-Kultanen *et al.*, 2014). The challenge in opening up such a continuum rests in supporting pre-service teachers in creating a personal plan for their ongoing professional development – a plan motivating them to develop their competences as future in-service teachers while strengthening their self-motivation. The Teacher Education Forum examines the challenges and opportunities for national development in Finland and suggests that pre-service teachers prepare a personal plan for developing the competences they will need in working life; the Forum also asserts that in-service teachers then should review these plans in relation to the development goals of their employing educational institution (OKM, 2016). According to Andersson and Köpsén (2015, p. 1), 'vocational teaching as a profession is based on a type of dual professionalism'; furthermore, 'vocational teachers are expected to be well qualified and up-to-date in the vocation they teach to meet the current expectations of working life'. As such, a teacher's personal plan for continuing professional development should aim to enhance the quality of both their teaching and their competences in their respective vocations. Following the principles of lifelong learning, professional development should be embedded sustainably in their daily practices, supporting the development of their profession (Kools and Stoll, 2016).

The working life and digitalisation of vocational education impose new demands on teachers' competences in digital pedagogy and efficient ICT use in learning (Koramo, Brauer and Jauhola, 2018; Ruhalahti and Kenttä, 2017). Digital technologies are changing current teaching and learning practices, leading to the formation of numerous guidelines and frameworks. For instance, the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2011) has released an ICT Competence Framework for Teachers. The professional competence development program investigated in this study follow national ICT-competency guidelines based on this UNESCO ICT-CFT. Meanwhile, the European Framework for Digitally Competent Educational Organisations (DigCompOrg) also promotes effective learning in the digital era (Kampylis, Punie and Devine, 2015). Such publications offer guidelines for the process of integrating digital learning technologies across Europe. In this context, it has become essential to find new tools for planning and conducting studies. More importantly, it remains important for teachers to achieve and maintain the versatile competences required to thrive in this environment.

Digital open badges offer detailed descriptions of the expertise and competences achieved (Brauer and Ruhalahti, 2014). Digital badging allows the gradual identification and recognition of competences, motivating the learner towards the achievement of intended learning outcomes (Brauer, Korhonen and Siklander, 2017). Siklander and Ruhalahti (2017) recently introduced digital open badge-driven learning as a multifaceted process with several layers that support different aspects of motivation in learning. They consider inspiring gamification to be a key factor in motivation. The progressive challenges in the performance required and intended learning outcomes can encourage enthusiasm for badge-driven learning while positively impacting learners' progress. Furthermore, digital badging supports success on a customised study path by allowing self-determined learning and flexibility in terms of time and place (Brauer, Korhonen and Siklander, 2017; Brauer, Siklander and Ruhalahti, 2017; Gamrat, Bixler and Raish, 2016). Swanson (2013) explains customisation as 'user-generated learning' brought about by contributions to 'a self-selected collaborative space' (pp. 11-12) in which learning happens 'on demand' (Kools and Stoll, 2016, p. 43), anytime and anywhere. Accordingly, all participants become actors in the user-generated process, actively searching for knowledge while contributing to evaluation and sharing. Digital pedagogy offers the potential to foster creativity, play, and problem solving in learning (Spiro, 2013). Spiro (2013) suggests combining theory with practice and creating with thinking in order to design learning that encourages participation, collaboration, public engagement, and even critical understanding of digital environments. Previous research has failed to identify the digital pedagogical tools and game-like elements that trigger student activity in badge-driven learning. There remains a need for up-to-date research supporting the visualisation of a

competence-development continuum; this line of inquiry must consider new directions, such as gamification and novel forms of online learning, especially in higher education.

Triggers of Gamified Digital Open Badge-Driven Learning

The commercial deployment of gamified applications for large audiences (Deterding, Dixon, Khaled and Nacke, 2011) has borrowed the term *gamification* from the digital media industry (Deterding, Khaled, Nacke and Dixon, 2011). The idea of gamification originates from human-computer interactions and game studies, specifically focusing on inventions that apply game elements and techniques in new contexts. Gamification enhances user motivation by arousing enthusiasm mirroring the excitement and enjoyment of playing games (Brauer, Siklander and Ruhalahti, 2017; Deterding, 2012, 2015). Though teachers have used different forms of educational games and gamified learning for years, the literature largely has overlooked this important topic (Kangas, Koskinen and Krokfors, 2017). Digital badges represent one under-researched area despite their ability to enhance digital pedagogical models easily and purposefully.

Instructors often use digital open badges to reward the learner with "game-like encouragement" in non-game and educational contexts (Reid, Paster and Abramovich *et al*., 2015, p. 379). Furthermore, Sailer, Hence, Mayr and Mandl (2017, p. 372) define 'gamification as the process of making activities in non-game contexts more game-like by using game design elements'. According to Deterding (2015), the 'gamefulness' of a design can be based on the elements people are accustomed to when playing games. Accordingly, the simplest components of gamification (e.g. badges, levels, points, and leaderboards) should be sufficient to provide the same sense of excitement as games (Brauer, Siklander and Ruhalahti, 2017; Deterding, 2012). Ultimately, the gamification of e-learning aims to trigger student engagement and support more efficient learning behaviour (Muntean, 2011).

Our paper draws on definitions that couple the concept of gamification with the triggers of online learning (Järvelä and Renninger, 2014; Renninger and Bachrach, 2015). Recent research has considered interest, motivation and engagement in the fields of education and educational psychology (Hidi and Renninger, 2006; Järvelä and Renninger, 2014; Renninger and Bachrach, 2015); these studies found that triggers play a key role in arousing and maintaining student interest. Roberts and Ousey (2004) define the term *trigger* as the initial stimulus that can be presented in a variety of ways to ensure that students enjoy learning. According to Muntean (2011 p. 324), a trigger is something that tells the participant "to complete the action in a certain moment". Renninger and Bachrach (2015) suggest research seeking a more complete understanding of the triggering process; specifically, they suggest more research into which triggers are most effective and which environmental features allow the triggered interest to be maintained.

In the field of online learning in higher education, Siklander, Kangas, Ruhalahti and Korva (2017) conclude that the most significant triggers are collaboration, topic and feedback. Collaboration includes rich and reciprocal forms of peer interaction and motivation. Meanwhile, the topic should represent a sufficiently difficult open problem for students. This demand for new challenges aligns with Brauer and Siklander's (2017) findings, suggesting that badges should provide students with progressively deeper and more complex challenges, similar to the progressive obstacles present in games. In their study, Sailer, Hence, Mandl and Klevers (2013) point out three motivational elements of gamification that primarily serve as triggers: points, badges and leaderboards. Dichev, Dicheva, Angelova and Agre (2014) state that the point's system serves as the core of many game dynamics; as such, the users desire to accumulate points in order to progress and attain higher levels. Dichev et al. (2014) have noted that participants must have a sense of achievement. Providing feedback with points and challenging achievements (i.e., leaderboards and levels organised in the badge constellation) satisfies students' intrinsic need for competence development (Brauer, Korhonen and Siklander, 2017; Jung, Schneider and Valacich, 2010). Veerpoorten, Westera and Specht (2012) have studied the context of online learning, showing that the use of reflection triggers makes the learning process more tangible. Indeed, these triggers have the potential to promote learners' interest and productive engagement.

Studies have shown more positive than negative effects of gamification on motivation (Hamari, Koivisto and Sarsa, 2014; Seaborn and Fels, 2015). For example, Brauer, Siklander and Ruhalahti (2017) indicate that motivation in digital open badge-driven learning is based more on achievement goals and triggers of online learning than on factors of intrinsic and extrinsic motivation. This argument finds support in Yildirim's (2017) notion that students' attention, motivation and interest directly relate to their achievements (cf. Martí-Parreño, Segui-Mas and Segui-Mas, 2016). Research also shows a positive relationship between gamification and student achievement (Buckley and Doyle, 2014; Domínguez *et al*., 2013). However, Seaborn and Fels (2015) point out that there is no theoretical foundation to explain these motivational effects. Dichev *et al*. (2014) state that, even if student motivation is high, the expected behaviour does not necessarily occur. They consider triggers to be the missing pieces in the process – inspiring sparks of hope, alarms or announcements from the facilitator, or simple signals prompting the students to proceed. Applying the proper trigger at the right time may push a participant across the threshold of activation. Werbach (2014) views gamification as a process and believes that user experiences trigger continued engagement. According to Lee and Hamer (2011), gamification gives students the freedom to learn without the fear of failure.

Because previous studies primarily emphasise the positive effects of gamification, there exists a serious research gap regarding the negative aspects of the phenomenon

(Hyrynsalmi, Smed and Kimppa, 2017). Despite this omission, several researchers acknowledge possible problems and consequences related to gamification. For instance, Hyrynsalmi *et al.* (2017) have categorized the limiting and harmful implications of gamification using a tertiary literature review. In addition to ethical questions (Bui, Weit and Webster, 2015; Kim and Verbach, 2016), they found some very practical challenges. For example, participants might become immersed in the game itself and forget the original purpose of the activity. Others might find the task too childish and simple to proceed (Augustin, Thiebes, Lins, Linden and Basten, 2016). Despite these negative elements, the results overwhelmingly suggest a need to focus more on the possibilities of gaming solutions than on the shortcomings (Hyrynsalmi et al., 2017).

In conclusion, triggers offer the potential to affect learning during several stages of the gamified digital open badge-driven learning process, arousing and maintaining interest (Hidi and Renninger, 2006; Järvelä and Renninger, 2014; Renninger and Bachrach, 2015) until completion of the desired learning action (Dichev *et al*., 2014). Triggers also allow students to continue studying after completing an initial task (Dichev *et al*., 2014; Werbach, 2014). In terms of digital open badge-driven learning, the prompting trigger for learning might come in the form of a reward badge and new level or in the sense of excitement achieved while playing games; the trigger might also manifest as interactions, collaborations or feedback from the facilitators of the learning process. However, because digital open badge-driven learning remains so new to researchers, we lack information regarding how triggers work in different learning situations and at varying stages of the learning process. Our research aims to study different stages and aspects of the badge-driven learning process and to explore the triggers in more detail.

Methodology

Research Question

This study seeks to identify those students who were particularly motivated by digital open badge-driven learning in relation to the competence-development continuum for vocational teachers; in particular, it considers the identification and recognition of digital pedagogical competences. The key research question is as follows: what triggers learning in badge-driven process?

Context and Participants

Conducted in the context of Finnish higher education, our study focuses on competence-based vocational teacher education, particularly the competence-development continuum for professional teachers. The subject of our study is the Learning Online professional development program (PDP) and the process of identifying and recognizing professional teachers' digital pedagogical competences. In terms of implementation type, Learning Online follows a gamified massive open online course (MOOC) model (Brauer, Siklander

and Ruhalahti, 2017). In this MOOC, badges represent the simplest components of game design elements (Brauer and Siklander, 2017; Deterding, 2015). The PDP's badge criteria follow national ICT-competency guidelines based on the UNESCO ICT Competency Framework for Teachers (2011). This standard (and its equivalents around the world) supports teachers' access to high-quality, continuous professional development (Kools and Stoll, 2016).

Professional development and its related activities should reflect the sum of competence required from teachers (Day, 2017). In Learning Online, digital open badges visualise the requisite skill sets (1–3) in a way that allows participants to plan and customise their personal study paths. The participants apply for competence-based digital badges by providing the required demonstration or evidence of the competence in question. Teacher trainers from different schools of professional teacher education facilitate the application and issuing process in the open-badge management system (Open Badge Factory).

Scaffolding is provided for remediation and rejection of the badge application. Participants also participate in a Facebook-based study group. Designed by professional teacher trainers, the badge anatomy and architecture are simplistic; however, the included metadata describe the competence criteria in detail, explaining the required evidence in the form of a tangible task. The competence-based approach encourages participants to put into practice their acquired skills and knowledge immediately (Brauer, Kettunen and Hallikainen*,* in press). In Learning Online, openly-licensed learning materials and badges are open to anyone interested in developing digital pedagogy and vocational training.

The participants (N=329) followed one out of three educational paths: 1) pre-service teachers given a pre-determined (compulsory) set of badges to attain, 2) pre-service teachers free to apply for any badges and 3) in-service teachers free to apply for any badges. All groups utilised the exact same constellation of badges (N=50+) for digital open badge-driven learning. The third group of participants represented the in-service teachers for whom the Learning Online PD was designed originally in a project funded by the Finnish National Agency for Education. Their experience with digital pedagogy and skills-set level (SSL) was measured by their achieved digital open badges, ranging from Some-Novice SSL 1 (N=132) to Some-Developer SSL 3 (N=26). A total of 94 participants achieved fewer than 10 badges [SSL 4]. All participants came from Finland, comprising 252 women and 77 men. They represented all disciplines of vocational education, with higher education degrees from different fields. They had varying years of experience in their working lives, ranging from less than two to over 20 years; however, nearly all participants had more than two years of experience in their respective professional fields. The youngest group of respondents included individuals under the age of 30 (N=6), and the eldest

participants were 60 years old and over (N=8). In total, 214 participants already had obtained their qualification to work as professional teachers; the earliest completed qualification was attained in 1982. More than a quarter of the participants had been working for over 20 years in their disciplines, and at the time of this study, 221 respondents were working in the educational sector at least part time. Nearly half of the participants were pre-service teachers; thus, they had no teaching experience yet.

Data

Using an online questionnaire, we collected quantitative data for analysis in the autumn of 2017. The Finnish language questionnaire was sent to all e-mail addresses (N=1246) registered in Learning Online's badge management system from 2014 to 2017. In total, 329 people responded to the questionnaire. There were 1100 potential participants after filtering out misspelled addresses and duplicates. The mailing list also included the contact information of teacher trainers and tutors; it also may have included some expired student IDs. Webropol statistics indicated that about half (N=561) of the recipients opened the questionnaire, and 329 responded to it. Answering the questionnaire was completely voluntary. The questionnaire included a cover letter providing participants with a description of the research as well as detailed information about how the data would be used. Personal identification data was accessed exclusively by the first author, and all data were anonymised in the survey software tool. We then double-checked for identifying personal information in Microsoft Excel before analysis on R for Vegan. All restored identifying information will be deleted permanently when the study is complete.

We employed an extensive set of quantitative multiple-choice questions to map explanatory background variables, such as experience and field of education (cf. Analysis). As shown in Table 1, participants responded to five statements using a Likert scale. We selected these statements based on the earlier findings of Brauer, Siklander and Ruhalahti (2017), research that delineated the variables affecting learning motivation in digital open badge-driven learning.

Table 1

Statements related to earlier research and abbreviations of study variables

It is important to me that…	***Variable affecting learning motivation***	***Variable to study***
1. I can study and demonstrate my skills in a flexible way, regardless of time and place.	Option to study regardless of time and place	FSO = flexible study options (time and place)
2. I can choose what to study in a free order.	Optional study paths	OCS = option to customise studies
3. The required evidence and demonstration of competence based on the badge criteria offer progressive challenges and variation in the extent of required performance.	Progressive challenges and the extent of required performance	V = the variety in extent of required performance
4. I learn new and up-to-date competencies, and I can keep track of my progress.	Study progress and enthusiasm for badge-driven learning	SP = option to learn new and up-to-date competencies and enthusiasm for badge-driven learning (study progress)
5. The PDP is gamified.	Inspiring gamification	G = gamified PDP

Analysis

We conducted this research using the statistical multivariate method of constrained correspondence analysis (CCA), also known as canonical correspondence analysis (Oksanen, 2012). The method selection is theoretical because there are several options for operating with multiple variables (Davison and Sireci, 2000; Johnson and Wichern, 2002; Rencer, 2002). Although the CCA is more commonly used in plant ecological research, it recently has been applied in behavioral studies (Venuleo, Ciavolino, Vernai, Marinaci and Calogiuri, 2018) and in educational contexts (Brauer *et al.,* in press). Both studies have noted the potential of CCA, seeking to further define the qualities of this descriptive statistical method compared to other approaches. Venuelo *et al*. (2018) explain the benefits of CA and CCA, suggesting that they provide a summary 'of dis (similarities) in the subjects' discourses to be obtained, by identifying the associative pattern assumed by a set of words in the data' (p. 212). This idea aligns with Ter Braak's (1986) statement that reciprocal averaging in eigenvector techniques is 'a popular ordination technique that extracts continuous axes of variation from species occurrence or abundance data' **(p. 1167).** Ter Braak (1986) emphasizes that researchers should supplement their interpretations of such

ordination axes with environmental-variable data and external knowledge. Spicer (2005) characterises mathematically elegant multivariate methods as tools that provide challenging results for interpretation, making them suboptimal for testing strong hypotheses.

Brauer, Siklander and Ruhalahti (2017) introduced different layers of digital open badge-driven learning. Based on their findings, we chose this particular method because it can visualise and identify a variety of variables related to the phenomena under investigation. We conducted the CCA by using the nine background variables (sex, age, province, study group, skill-set level [SSL], occupation, field of education, working experience and teacher qualification) explaining the variables affecting learning motivation (Brauer, Siklander and Ruhalahti, 2017). We selected these variables to extract common features and to evaluate linear combinations between two multidimensional variable sets. The method enabled us to visually plot the relationships between study items while also allowing us to add the dummy-coded categories of the background variables (demographics) as gradient vectors into the same plot. Additionally, we used permutation tests to determine the statistical significance of the relationships between the study items and the background variables. Thus, we felt encouraged to test the method in educational research, and we confirmed the findings in the CCA plot (Figure 1) by checking the Spearman's rank-order correlation matrix of the five study items and the distributions of the values of the five-point Likert scale by the groups of the respondents. R package vegan was used to compute the CCA (Oksanen *et al.*, 2017).

The Results of Constrained Correspondence Analysis

CCA inertia was divided mostly to the unconstrained axes (Table 2), similar to the magnitude of the eigenvalues of the two most important axes. The background variable called SSL was the only significant explanatory variable found when testing the nine background variables using permutation tests (Table 3). In order to make the CCA plot more interpretable, we rescaled the coordinate values of the five study items for CCA plot (CCA1 and CCA2) by multiplying the original coordinate values by 10.

Table 2

The share of inertia of the CCA model

	Inertia	***Proportion***	***Rank***
Total	*0.0250*	*1.0000*	
Constrained	*0.0012*	*0.0484*	*3*
Unconstrained	*0.0238*	*0.9516*	*4*

The eigenvalues for constrained axes 1 and 2 were CCA1 9.079e-4 and CCA2 2.999e-4. The eigenvalues for unconstrained axes 1 and 2 were 11.9522e-3 and 5.670e-3.

Table 3

The permutation test for the CCA under the reduced model

	Df	Chi-sq	F	Pr(>F)
Skill-set level (SSL)	3	0.00012	2.594	0.004
Residual	153	0.02381		

The tables above demonstrate that the identification of student profiles was not associated, for instance, with subgroups of in-service and pre-service teachers; rather, it related to the competence-development continuum for vocational teachers and the identification and recognition of digital pedagogical competences. We observed only one significant explanatory variable in identifying students who were particularly motivated by digital open badge-driven learning: skill-set level [SSL]. Because of this finding, we studied the variables affecting student motivation during the digital open badge-driven learning process only in relation to their achieved SSL.

Generally, multivariate methods aim to reveal simplified structures based on information about the distance, similarity or difference between observations (Akaho, 2006; Hardoon, Szedmak and Shawe-Taylor, 2004). We iteratively searched the data-specific distances in order to present the findings, identifying and labelling the dimensions based on visual inspection, subjective interpretation and respondent information (Ding, 2006). Figure 1 illustrates the relationships between the five study items (Table 1) and the attached gradient vectors for the SSL categories. We did not display the first category because it was a redundant parameter; according to the dummy-coding scheme, the coordinates were situated at origo. Our purpose was to present the phenomenon such that the interpretation would be as simple as possible without losing any relevant information. Furthermore, we used triangulation to evaluate the results and increase their validity.

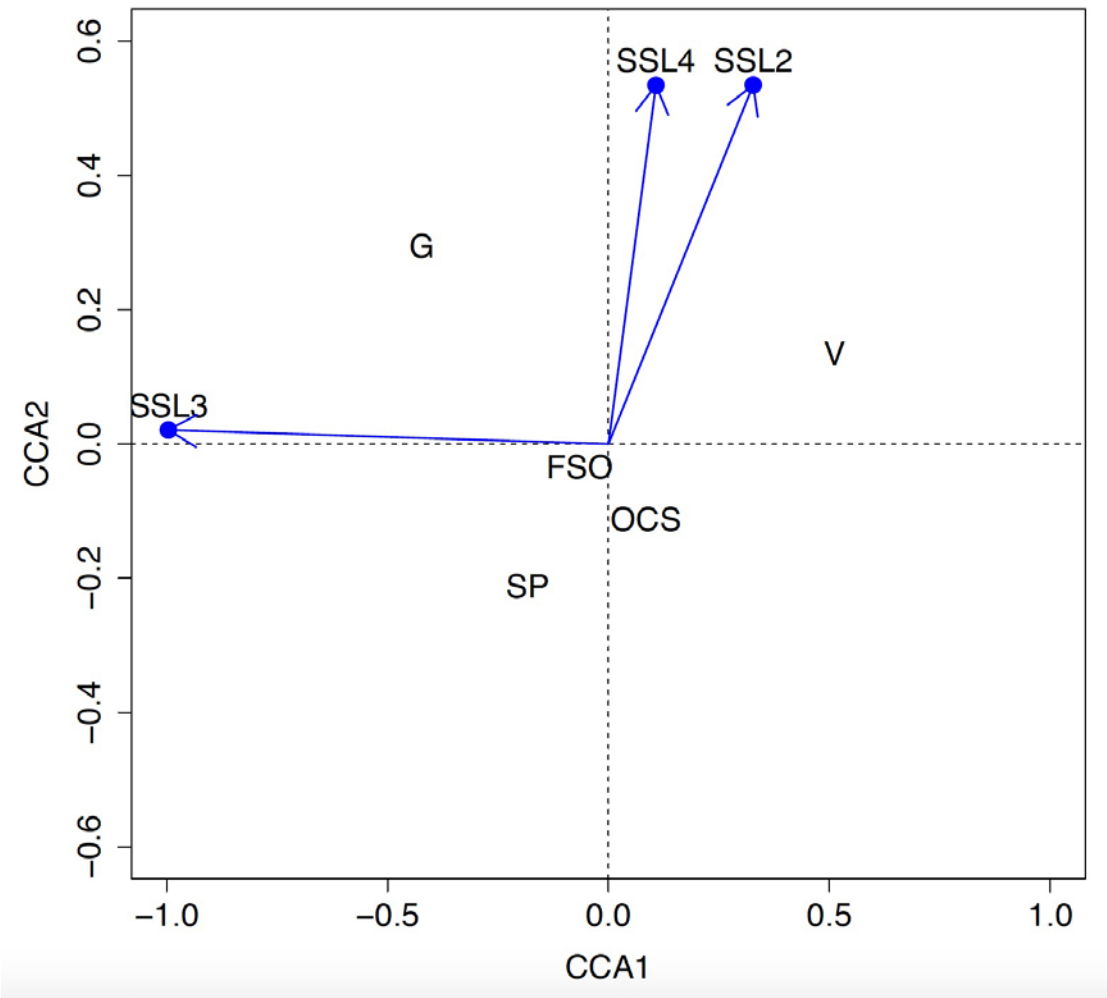

Figure 1. CCA plot with two dimensions.

Symbols representing the background variable (SSL = skill-set level) and the online questionnaire statements: FSO = flexible study options (time and place), OCS = option to customise studies, V = variety in the extent of required performance, SP = option to learn new and up-to-date competences (study progress) and G = gamified PDP.

Keeping in mind the risk of interpreting insignificant functions, researchers should only interpret the functions explaining the variance between variable sets (Sherry and Henson 2005). Figure 1 represents a simplification of various dimensions of the digital open badge-driven learning process. Five statements were addressed (cf. Table 1) based on earlier findings documented in the literature. In this study, we sought to explain these variables affecting learning motivation by using nine background variables. However, our analysis revealed only one significant variable, achieved SSL (Table 3). As such, this was the only variable we could use to interpret and explain the variance and to evaluate linear combinations of the relationships (Akaho, 2006; Hardoon *et al.,* 2004). Our results indicate the significance of certain variables that affect motivation in the digital open badge-driven learning process. Based on these results, the following triggers appear to be meaningful in digital open badge-driven learning: the option of flexible study (time and

place), the option to customise studies, the option to learn new and up-to-date competences and gamification.

Discussion

The current paper contributes to the search for novel methods in educational research by introducing constrained correspondence analysis as a tool for quantitative research. In the present study, we used the method to identify student profiles associated with subgroups of in-service and pre-service teachers, particularly in terms of their competence-development continuum as vocational teachers. This methodological choice met our expectations; it offered a means of describing the phenomenon through quantitative research. The research question sought to ascertain which aspects trigger learning in the badge-driven learning process. The results suggest that it might be important to identify different subgroups. The critical variable related to achieved skills set levels and not, for instance, to pre- or in-service teacher status. These findings imply that these subgroups derive the most advantages from digital open badge-driven learning.

Statistical-mathematical multivariate methods face challenges that may can be perceived as reducing the data and simplifying the structure; in complex situations, the linearity of analysis might extract useful features (Akaho, 2006). However, previously-published research supports our study's findings regarding digital open badge-driven learning and motivation (Brauer, Siklander and Ruhalahti, 2017). Together with the theoretical framework of triggers, the literature enables us to evaluate the reliability of the results. Theoretically, our study draws from recent research into the concepts of gamification (Deterding, 2015, 2012; Reid *et al.,* 2015), the triggers of online learning (Hidi, 2000) and the triggering effect of gamification in learning (Dichev et al., 2014; Muntean, 2011). Based on the literature and our findings, we propose three primary contributions.

First, we found flexible study options to be the most important trigger of learning at the requisite SSL 1 (coordinates situated at origo) for novice teachers (i.e., those who are just starting to develop their digital pedagogical competences). These findings align with prior research indicating that the option to study at any time in any place is the second-most important factor affecting student motivation in digital open badge-driven learning (Brauer, Siklander and Ruhalahti 2017). Flexible study options support self-determined studying; Brauer, Siklander and Ruhalahti, 2017; Gamrat, Bixler and Raish, 2016). Further, the option to self-select the time and place of learning allows the customisation of one's studies (Swanson, 2013).

Second, the *option to customise studies* represents another central principle explaining novice teachers' [SSL 1] eagerness to choose which badges to apply based on their individual requirements and occupational needs. These results are consistent with

earlier findings that study path visualisation provides an interface for customisation (Brauer, Siklander and Ruhalahti, 2017; Casilli and Hickey, 2016; Gamrat *et al.,* 2016; Swanson, 2013). Further, customised study paths arouse interest and maintain students' motivation and engagement as their studies progress (Hidi and Renninger, 2006; Järvelä and Renninger, 2014; Renninger and Bachrach, 2015). Our study indicates positive relationships between *flexible study options* (time and place), *the option to customise studies* and *the option to learn new and up-to-date competences* (study progress); these areas appear to be important for students at advanced levels of professional development. Most of the students at SSL 3 are experienced in-service teachers requiring especially flexible ways of advancing their own knowledge as well as the skills needed in working life. As Kools and Stoll (2016) put it, 'Professional development and learning need to be embedded into the workplace' (p. 40). These teachers appreciate opportunities to continue their professional development in order to deepen their existing competences.

Third, our analysis reveals that gamification is remarkable (cf. Figure 1) in relation to all skill set levels. These findings indicate that gamification is also perceived as positively affecting student achievement. This idea parallels the findings of several previous studies (Buckley and Doyle, 2014; Domínguez et al., 2013; Sailer, Hence, Mayr and Mandl, 2017) noting that gamification enhances human motivation and offers to substantially improve performance in a given task. Brauer, Siklander and Ruhalahti (2017) state that study progress motivates students only to a certain degree, and that inspirational play through gamification encourages students to continue their studies. Indeed, learners can identify progressive challenges and the degree of performance required to trigger badge-driven learning. As Muntean (2011) notes, gamification is a trigger that tells the participant to proceed. Badges explain what students experience, learn and apply in detail. However, our results indicate that gamification, the variety in the extent of required performance, and progressively deeper and more complex challenges (Abuhamdeh and Csikszentmihalyi, 2009; Deterding, 2015; Roberts and Ousey, 2004) especially support both novice and expert-level students. Gamification appears to motivate these two groups even at the very beginning of their pursuits *(*cf. Hamari, Koivisto and Sarsa, 2014; Seaborn and Fels, 2015) when their study paths and the progress in studies would be difficult to understand otherwise. These findings confirm Yildirim's (2017) conclusion that students' attention, motivation and interest are directly correlated with their achievements.

Limitations and Implications

Our study does have limitations. The sample was not completely random in that we selected active teachers as respondents. The sample size was also too small to provide completely reliable results; we cannot exclude the possibility that our findings could be the expression of other latent or unexplored factors related to the phenomenon. Despite the fact that we applied an appropriate sampling plan, these factors may have affected the content with respect to the variables, the descriptive functions, or the generalization of relationships. It is possible that a larger dataset would have provided different results. The first author performed the coding of the sample, and the third author was responsible for the sampling design and the descriptive community analysis (Oksanen et al., 2018). The original survey and the final results were revised using researcher triangulation to increase the validity of findings *(Heale* and Twycross, 2015). We also confirmed the consistency of results and ensured a high reliability of strong correlations by checking the Spearman's rank-order correlation matrix for the five study items.

Inevitably, this study also faces limitations related to the researcher's positioning (see Yin, 2009). The two primary authors of this study were involved in the design and implementation of the Learning Online PDP as well as in the data analysis. Therefore, their assumptions and actions may have influenced the research process, and the results may not be generalizable to other contexts of implementation where the researchers do not influence the proceedings so directly (Barab and Squire, 2004). The reliability of the study could have been enhanced by having a third author independent from the study to analyse the initial data (i.e., someone not working with the PDP). Although two of the authors of this article have been involved in developing the Learning Online PDP from the beginning, our research does not take a stand on the functionality of the educational or technical elements of the investigated PDP. Ultimately, our research in this particular context aims to inspire further studies on the different layers of digital open badge-driven learning.

Gamification of digital open badge-driven learning seems to improve student performance and learning outcomes substantially (Abramovich, Schunn and Higashi, 2013; Reid et al., 2015). However, earlier qualitative research did not yield information regarding whether or not the effects of gamification are the same for all students (Dichev et al., 2014). In terms of educational implications, we suggest applying gamification and digital badges for the professional development of both pre- and in-service teachers. We also propose that curriculum designers consider the option for flexible study, the option to customise studies and the option to learn new and up-to-date competences triggering digital open badge-driven learning. Additionally, we suggest further studies on digital open badge-driven learning to evaluate the linear combinations of different study groups, gamification, collaboration and the required

forms of evidence. In the context of this study, the variable of the study group was considered noteworthy even if insignificant according to our obtained data. The results suggest an interesting positive relationship with gamification serving as the strongest predictor of study group success even if variety in the extent of required performance is negatively related. In the future, we aim to find out why (if) progressively deeper and complex game-like challenges trigger learning in study groups (Muntean, 2011) without being as efficient as gamification in terms of community building and collaboration.

References

ABUHAMDEH, S., and CSIKSZENTMIHALYI, M., (2009). Intrinsic and extrinsic motivational orientations in the competitive context: An examination of person-situation interactions. *Journal of Personality*, **77**(5), pp.1615–1635.

ABRAMOVICH, S., SCHUNN, C., and HIGASHI, R. M., (2013). Are badges useful in education? It depends upon the type of badge and expertise of learner. *Educational Technology Research and Development*, **61**(2), pp.217–232.

AKAHO, S., (2006). A kernel method for canonical correlation analysis. *arXiv preprint cs/0609071*.

ANDERSSON, P., and KÖPSÉN, S., (2015). Continuing professional development of vocational teachers: participation in a Swedish national initiative. *Empirical Research in Vocational Education and Training,* **7**(7), https://doi.org/10.1186/s40461-015-0019-3

AUGUSTIN, K., THIEBES, S., LINS, S., LINDEN, R., and BASTEN, D., (2016). Are We Playing Yet? A Review of Gamified Enterprise Systems. *PACIS 2016* (p. Paper 2.). AIS.

BARAB, S., and SQUIRE, K., (2004). Design-based research: Putting a stake in the ground. The Journal of the Learning Sciences, **13**(1), pp.1–14.

BRAUER, S., KETTUNEN, J. and HALLIKAINEN, V., (in press). “Learning Online” for Vocational Teachers - Visualisation of Competence-based-approach in Digital Open Badge-Driven Learning.

BRAUER, S., and RUHALAHTI, S., (2014). Osoita osaamisesi osaamismerkein [Show your competences with digital badges]. In A.-M. Korhonen and S. Ruhalahti, eds, *Oppimisen digiagentit*. HAMKin e-julkaisuja 40/2014. pp. 87-92. Available from https://publications.theseus.fi/bitstream/handle/10024/85417/HAMK_ Oppimisen_digiagentit_ekirja.pdf

BRAUER, S., and SIKLANDER, P., (2017). Competence-based assessment and digital badging as guidance in vocational teacher education. In H. Partridge, K. Davis and J. Thomas, eds, *Me, Us, IT! Proceedings ASCILITE2017: 34th International Conference on Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education*, Toowoomba, Australia, pp.191-196.

BRAUER, S., SIKLANDER, P., and RUHALAHTI, S., (2017). Motivation in digital open

badge- driven learning in vocational teacher education. *Ammattikasvatuksen Aikakauskirja,* **19**(3), pp.7–23.

BUCKLEY, P., and DOYLE, E., (2014). Gamification and student motivation. *Interactive Learning Environments,* pp.1-14. doi:10.1080/10494820.2014.964263

BUI, A., VEIT, D., and WEBSTER, J., (2015). Gamification - A Novel Phenomenon or a New Wrapping for Existing Concepts? *Thirty Sixth International Conference on Information Systems.* AIS. pp. 1-21.

DAVISON, M. L., and SIRECI, S. G., (2000). Multidimensional scaling. In H. E. A. Tinsley and S. D. Brown, eds, *Handbook of applied multivariate statistics and mathematical modeling*, San Diego, CA: Academic Press, pp.323–352.

DAY, C., (2017). Competence-based Education and Teacher Professional Development. In M. Mulder, eds, *Competence-based Vocational and Professional Education. Technical and Vocational Education and Training: Issues, Concerns and Prospects,* **23**, pp.165-182. doi.10.1007/978-3-319-41713-4_8

DETERDING, S., (2012). Gamification: designing for motivation. *Interactions*, **19**(4), pp.14– 17.

DETERDING, S., (2015). The Lens of Intrinsic Skill Atoms: A Method for Gameful Design. *Human - Computer Interaction* **30**(3–4), pp.294–335. doi.10.1080/07370024.2014.993471

DETERDING, S., KHALED, R., NACKE, L. and DIXON, D., (2011). Gamification: Toward a Definition, *CHI 2011 Gamification Workshop Proceedings*, Vancouver, Canada.

DETERDING, S., DIXON, D., KHALED, R. and NACKE, L., (2011). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* ACM, pp.9-15.

DICHEV, C., DICHEVA, D., ANGELOVA, G. and AGRE, G., (2014). From gamification to gameful design and gameful experience in learning. *Cybernetics and Information Technologies*, **14**(4), pp.80-100.

DING, C. S., (2006). Multidimensional scaling modelling approach to latent profile analysis in psychological research. *International Journal of Psychology*, **41**(3), pp.226-238.

DOMÍNGUEZ, A., SAENZ-DE-NAVARRETE, J., DE-MARCOS, L., FERNÁNDEZ-SANZ, L., PAGÉS, C. and MARTÍNEZ-HERRÁIZ, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education,* **63**, pp.380–392.

GAMRAT, C., BIXLER, B., and RAISH, V., (2016). Instructional Design Considerations for Digital Badges. *Digital Badges in Education: Trends, Issues, and Cases*, pp.71–81.

GLATTHORN, A., (1995). Teacher development. In L. Anderson, ed, *International encyclopedia of teaching and teacher education.* (Second edition). London: Pergamon Press.

HAMARI, J., KOIVISTO, J. and SARSA, H., (2014). Does Gamification Work? — A Literature Review of Empirical Studies on Gamification. *Proceeding HICSS 2014: 47th International Conference on System Science,* Hawaji, USA, pp.3025–3034.

HARDOON, D. R., SZEDMAK, S. and SHAWE-TAYLOR, J., (2004). Canonical Correlation Analysis: An Overview with Application to Learning Methods. *Neural Computation*, **16**(12), pp.2639–2664.

HEALE, R. and TWYCROSS, A., (2015). Validity and reliability in quantitative studies. Evidence-Based Nursing, **18**, pp.66-67.

HIDI, S., (2000). An interest researcher's perspective: The effects of extrinsic and intrinsic factors on motivation. In C. Sansone and J.M. Harackiewicz (Eds.) *Intrinsic and extrinsic motivation: The search for optimal motivation and performance,* New York: Academic, pp.311–33.

HIDI, S., and RENNINGER, K.A., (2006). The Four-Phase Model of Interest Development.
Educational Psychologist, **41**(2), pp.111–127.

HYRYNSALMI, S., SMED, J. and KIMPPA, K., (2017). The Dark Side of Gamification: How We Should Stop Worrying and Study also the Negative Impacts of Bringing Game Design Elements to Everywhere. *Proceedings of the 1st International GamiFIN Conference.* Pori, Finland. Available from: https://www.researchgate.net/publication/316755065_The_Dark_Side_of_Gamification_How_We_Should_Stop_Worrying_and_Study_also_the_Negative_Impacts_of_Bringing_Game_Design_Elements_to_Everywhere

JÄRVELÄ, S. and RENNINGER, K.A., (2014). Designing for learning: Interest,

motivation, and engagement. In (R.K. Sawyer, Ed.) *Cambridge handbook of the learning sciences*, pp. 668–685. Cambridge, UK: Cambridge University Press.

JOHNSON, R. A., and WICHERN, D. W., (2002). *Applied Multivariate Statistical Analysis.* 5th edition. Prentice Hall.

JUNG, J., SCHNEIDER, C. and VALACICH, J., (2010). Enhancing the motivational affordance of information systems: the effects of real-time performance feedback and goal setting in group collaboration environments. *Management Science,* **56**, pp.724–742.

KAMPYLIS, P., PUNIE, Y. and DEVINE, J., (2015). *Promoting effective digital-age learning: A European framework for digitally-competent educational organisations.* EUR 27599. DOI.10.2791/54070

KANGAS, M., KOSKINEN, A., and KROKFORS, L., (2017) A qualitative literature review of educational games in the classroom: the teacher's pedagogical activities, *Teachers and Teaching*, **23**(4), pp.451-470, DOI: 10.1080/13540602.2016.1206523

KIM, T. W., and WERBACH, K., (2016). More than just a game: ethical issues in gamification. *Ethics in Information Technology*, **18**, pp.157-73.

KOOLS, M., and STOLL, L., (2016). What Makes a School a Learning Organisation? *OECD Education Working Papers*, **137**, OECD Publishing, Paris. DOI: 10.1787/5jlwm62b3bvh-en

KORAMO, M., BRAUER, S., and JAUHOLA, L., (in press). DIGAM - Digitalisaatio ammatillisessa koulutuksessa. [Digitalisation in vocational education].

LEE, J. J. and HAMMER, J., (2011). Gamification in Education: What, How, Why Bother? *Academic Exchange Quarterly,* **15**(2), pp.146.

MAHLAMÄKI-KULTANEN, S., LAURIALA, A., KARJALAINEN, A., RAUTIAINEN, A., RÄKKÖLÄINEN, M., HELIN, E., POHJONEN, P. and NYYSSÖLÄ, K. (2014). Opettajankoulutuksen tilannekatsaus. [Status Report of Teacher Training], Tilannekatsaus marraskuu 2014. Muistio 2014:4 Available from http://www.oph.fi/download/163626_opettajankoulutuksen_tilannekatsaus.pdf

MARTÍ-PARREÑO J., SEGUÍ-MAS D. and SEGUÍ-MAS E., (2016). Teachers' Attitude

Towards and Actual Use of Gamification. *Procedia - Social and Behavioural Sciences,* **228**, pp.682–688.

MUNTEAN, C.I., (2011). Raising engagement in e-learning through gamification. In *Proc. 6th International Conference on Virtual Learning ICVL* No. 42, pp.323-329.

OECD. (2018). *The OECD Teaching and Learning International Survey*. Available from http://www.oecd.org/edu/school/talis.htm

OKM. (2016). *Opettajankoulutuksen kehittämisen suuntaviivoja. Opettajankoulutusfoorumin ideoita ja ehdotuksia.* [Guidelines for Developing Teacher Education. Teacher Education Forum Ideas and Suggestions], Teacher Education Forum. Opetus- ja kulttuuriministeriön julkaisuja 2016:34. Available from http://minedu.fi/documents/1410845/3985888/Opettajankoulutuksen+kehitt%C3%A4misen+suuntaviivoja+-+Opettajankoulutusfoorumin+ideoita+ja+ehdotuksia/0e6d21d6-3d3d-49a7-9c1f-bf9595a28211/Opettajankoulutuksen+kehitt%C3%A4misen+suuntaviivoja+-+Opettajankoulutusfoorumin+ideoita+ja+ehdotuksia.pdf

OKSANEN, J., (2012). *Unconstrained ordination: tutorial with R and vegan*. Available from http://cc.oulu.fi/~jarioksa/opetus/metodi/sessio2.pdf.

OKSANEN, J., BLANCHET, F.G, FRIENDLY, M., KINDT, R., LEGENDRE, P., MCGLINN, D., MINCHIN, P.R., O'HARA, R.B., SIMPSON, G.L., SOLYMOS, P., STEVENS, M.H.H, SZOECS, E. and WAGNER, H. (2017). *Vegan: Community Ecology Package. R package version 2.4-3.* Available from https://CRAN.R-project.org/package=vegan.

OKSANEN, J., BLANCHET, F.G, FRIENDLY., M., KINDT, R., LEGENDRE, P., MCGLINN, D., MINCHIN., P.R., O'HARA, R.B., SIMPSON, G.L., SOLYMOS, P., STEVENS, M.H.H, SZOECS, E. and WAGNER, H. (2018). Community Ecology Package. R package version 2.4-6. Available from: https://cran.r-project.org/web/packages/vegan/vegan.pdf

REID, A. J., PASTER, D. and ABRAMOVICH, S., (2015). Digital badges in undergraduate composition courses: effects on intrinsic motivation. *Journal of Computers in Education*, **2,** (4), pp.377–398.

RENCER, A. C., (2002). *Methods of Multivariate Analysis.* 2nd edition. John Wiley and Sons, Inc.

RENNINGER, K. A., and BACHRACH, J. E., (2015). Studying triggers for interest and engagement using observational methods. *Educational Psychologist*, **50**(1), pp.58–69.

ROBERTS, D. and OUSEY, K., (2004). Problem based learning: developing the triggers. Experiences from a first wave site. *Nurse Education in Practice,* **4,** pp.154–158.

RUHALAHTI, S. and KENTTÄ, V., (2017). Ammatillisen koulutuksen digitalisaatio ja työelämäyhteistyö [Digitalisation and collaboration with a world of work in vocational education] Available from http://www.oph.fi/julkaisut/2017/ammatillisen_koulutuksen_digitalisaatio_ja_tyoelama yhteisty

SAILER, M., HENCE, J., MAYR, S.K. and MANDL, H., (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior,* **69,** pp.371–380.

SAILER, M., HENSE, J., MANDL, H. and KLEVERS, M., (2013). Psychological perspectives on motivation through gamification. *Interaction Design and Architecture(s) Journal— IxD&A,* **19**, pp.28–37.

SEABORN, K., and FELS, D. I., (2015). Gamification in theory and action: A survey. *International Journal of Human-Computer Studies,* **74**, pp.14–31.

SHERRY, A., and HENSON, R.K., (2005). Conducting and interpreting canonical correlation analysis in personality research: A user-friendly primer. *Journal of personality assessment*, **84**(1), pp.37-48.

SIKLANDER, P. KANGAS, M., RUHALAHTI, S. and KORVA. S., (2017). Exploring triggers for arousing interest in the online learning. In L. Gómez Chova, A. López Martínez and I. Candel Torres, eds, *INTED2017 Proceedings 11th International Technology, Education and Development Conference, March 6th-8th, 2017,* Valencia, Spain, pp.9081-9089.

SPICER, J., (2005). *Making sense of multivariate data analysis: an intuitive approach*. Thousand Oaks, Calif: Sage Publications.

SWANSON, K., (2013). *Professional learning in the digital age: the educator's guide to user-generated learning*. Larchmont, NY, Eye on Education.

TAAJAMO, M., PUHAKKA, E., and VÄLIJÄRVI, J., (2015). *Opetuksen ja oppimisen kansainvälinen tutkimus TALIS 2013. Tarkastelun kohteena alakoulun ja toisen asteen oppilaitosten opettajat ja rehtorit.* [International Study on Teaching and Learning TALIS 2013. Teachers and Rectors of Primary Schools and Secondary Education] Opetus- ja kulttuuriministeriön julkaisuja 2015:4. Available from http://okm.fi/OPM/Julkaisut/2015/TALIS_2013.html

TER BRAAK, C. J., (1986). Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, *67*(5), pp.1167-1179.

UNESCO. (2011). *UNESCO ICT Competency Framework for Teachers.* Available from http://unesdoc.unesco.org/images/0021/002134/213475e.pdf

VEERPOORTEN, D., WESTERA, W. and SPECHT, M., (2012). Using reflection triggers while learning in an online course. *British Journal of Education Technology,* **43**(6), pp. 1030–1040.

VENULEO, C., CIAVOLINO, E., VERNAI, M., MARINACI, T. and CALOGIURI, S. (2018). Discourses on Addiction among Gamblers and Drug Users in Treatment. An Analysis of the Interviews through Constrained Correspondence Analysis. *International Journal of Mental Health and Addiction*, pp.1-18.

WERBACH, K., (2014). (Re) defining gamification: A process approach. In A. Spagnolli, L. Chittaro, and L. Gamberini, eds, *9th International Conference on Persuasive Technology, PERSUASIVE 2014*, **8462**, Cham: Springer International Publishing. pp.266–272.

YILDIRIM, I., (2017). The effects of gamification-based teaching practices on student achievements and students 'attitude toward lessons. *Internet and Higher Education,* **33**, pp.86–92.

YIN, R. K., (2009). Case study research. Thousand Oaks, CA: Sage.