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Abstract: The aim of this large-scale study was to understand the technology acceptation of learning management systems (LMS) by secondary school teachers and to investigate the instructional use of LMS, distinguishing between informational use and communicational use. The predictive model further includes: perceived usefulness, perceived ease of use, subjective norm, personal innovativeness in the domain of information technology, experience and internal ICT support at school level. Data were collected from 505 Flemish secondary school teachers. After performing satisfactory reliability and validity checks, the study was able to support all relationships among the 9 variables. Informational use was found to be a precursor for communicational use, perceived ease of use of the LMS is the strongest predictor in LMS-acceptation. Internal ICT support has a direct effect on the informational use of the LMS and on subjective norm. Implications stress that secondary school managers in education should take into account the importance of a teachers' efforts and performance perceptions and the direct and indirect impact of internal ICT support on LMS adoption.

Researching instructional use and the technology acceptation of Learning Management Systems by secondary school teachers

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Revision letter of manuscript CAE-D-11-00281

Dear editor and reviewers,

We would like to thank you for the constructive feedback in relation to our research and article. We believe that your thoughtful comments have helped to improve the quality of our paper in a substantial way. Therefore, we considered all your remarks and tried to overcome all shortcomings as mentioned in your review.

We will now go into detail about the revisions made based on your comments. Every comment is followed by our reaction first, and thereafter continues with the revised text (revised = blue color).

1. Reviewer #1:

(1) Suggest that integrating the foreword and "Literature review" section into the introduction section for more strongly background about studies of the Technology Acceptance Model (TAM).

Reaction on comment:

We support the demand of reviewer #1 to reorder the structure of our introduction. We revised the composition, deleted the heading “1 Literature review” between the sections mentioned above and added “1 Introduction” at the beginning of the article.

Revisions made on Introduction (page 2-3)

1. Introduction

1.1 Technology acceptance

Learning Management Systems (LMS; also referred to as Virtual Learning Environments, Digital Learning Environments, Course Management Systems or Electronic Learning Environments) are web based applications, running on a server and accessible with a web browser from any place with an Internet connection. LMS give educators tools to create online course websites, and provide access to learning materials (Cole & Foster, 2008). LMS find their origins in the late nineties. The current commercial market leader Blackboard was founded in 1997. Their open source opponent Moodle was established in 1999 (Delta Initiative, 2009). At the start, individual educators also adopted “home-made” solutions, combining a number of basic tools such as navigation, text forums, roles, etc. By 2004, most universities felt a need to centralize their elearning systems and moved to a single, centrally hosted and supported environment (Weller, 2010). Today, most LMS provide a number of basic set of specific tools and functionalities to support learning.

Recent research shows that there has been a permanent market rise in the use of LMS in higher (Kember, McNaught, Chong, Lam & Cheng, 2010) and secondary education (De Smet & Schellens, 2009; Pynoo, Devolder, Tondeur, van Braak, Duyck & Duyck, in press). The last Educause Report confirms that almost 90% of all responding American universities and colleges reported the availability of an LMS and related support for faculty and students (Arroway, Davenport, Xu & Updegrove, 2010).

Despite this high adoption rate, little is known how LMS benefit learning (Koszalka & Ganesan, 2004), how the use of these systems is related with teacher and student perceptions about teaching and learning (Lonn & Teasley, 2009), or about the technology acceptance of LMS (Van Raaij & Schepers, 2008; Sánchez & Hueros, 2010). In the current article, the objective is to research the reasons behind the technology acceptation of learning management systems (LMS) by secondary school teachers, and to investigate the instructional use of the LMS-use within this group of teachers.

Early social theories, like the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975), introduced descriptive models to study individuals’ intended behavior. According to this theory, someone’s behavior is primarily determined by his or her intention to perform that behavior. This intention is, in turn, influenced by two factors, namely the person’s attitude toward performing this

behavior and the perceived social pressure to engage in action.
In line with the Technology Acceptance Model (TAM) of Davis (1989), intended behavior involves two primary and direct related predictors: perceived usefulness (e.g., using a specific technology will increase their job performance) and perceived ease of use (e.g., using a specific technology will not require much effort).
To predict the acceptance of new technologies, TAM and its successor TAM2 (Venkatesh & Davis, 2000) received a lot of attention (Sun & Zhang, 2006). Comparative studies confirm the supremacy of the TAM over other intentional behavior models and theories (Matthieson, 1991). Legris, Ingham, and Collerette (2003) concluded that TAM has been widely adopted with different technologies and in various contexts and successfully predicted 40% of a system's use.

2. Reviewer #1:

(2) It needs to describe the sampling strategy of this study (e.g., area (urban/rural) of schools, academy degree and major of teachers, etc.).

Reaction on comment:

Given the remarks of reviewer #1, we added information on the urbanization level in Belgium and the courses taught by the participants.

We would like to point out that urbanization was not mentioned as a stratification variable, because of the specific situation in our region (Flanders). Based on information provided by the Directorate General Statistics and Economic Information (DGSEI) – the official organization that is in charge of the national (official) statistics in Belgium – it can be concluded that Flanders is a highly urbanized area with almost no rural areas left. These findings were also confirmed by data of the United Nations on population density (World population prospects, the 2010 Revision).

Two of our stratification variables are based on the way education is organized in Belgium, e.g. "teaching levels". The official statistics report the following percentage secondary school students divided per teaching level: 1^{th} (32%), 2^{nd} (32%), 3th (35%) and 4^{th} (1%). In our research we checked in which teaching level our teachers were teaching most frequently and we found the following results: 1^{th} (18%), 2^{nd} (24%), 3th (39%) and 4^{th} (1%). 18% didn't report a specific teaching level (some teachers combine teaching levels and some of the teachers don't teach within a specific teaching level). These findings demonstrate clearly that the distribution of the levels in our sample is very close to the distribution of the levels in the population. We assume that documenting this data in more detail is not advisable, as we would have to explain these local educational rules and structures in order to make them understandable. In doings so, we would risk to confuse our readers with data that has only local relevance. A similar stratification variable is "the type of secondary education (general, technical, and vocational)." As these types of secondary education, not even mentioning their sublevels, do not exist in other countries, we choose to report briefly on them.

Revisions made on Participants (page 10)

Teachers were recruited as participants in the study via their schools. About seventy-two schools were willing to participate, counting for data from 505 teachers (41% response rate). This teacher sample was closely studied and found to be representative for the population, considering the variables "teaching levels in Flemish secondary education" (age level 12 to 18 years) and the type of secondary education (general, technical, and vocational). Respondents were given the option to fill out a paper and pencil version or an online version of the research instruments. Of the 505 questionnaires, 129 questionnaires were completed online, 376 were collected on paper. Post hoc, independent sample t-tests were used to check differences in answer patterns. No significant differences were found in response patterns between the two presentation formats.

All participating schools are situated in an urban area. Belgium, and the region of Flanders in particular, is one of the world's most urbanized countries in the world (United Nations World populations prospects, 2011). The sample consisted of 57.3% female respondents, which is close to the percentage (61.5%) in the population (Flemish Ministry of Education and Training, 2008). Teacher age range varied from 22 to 61 years, with an average age of 40 (SD = 10.5), teacher experience ranged from 1 to 42 years, with an average of 15 (SD = 10.8). We grouped participants based on the courses they teach and found out that 24% of them are language teachers (Dutch, French, English, German, Spanish, Latin, Greek etc.), 24% science teachers (math, biology, geography etc.), 18% reported teaching technical or vocational courses (electricity, haircut, hotel etc.) and 34% general courses (history, economy etc.).

Added to References (page 18-22)

United Nations, Population Division. World population prospects — the 2010 revision. New York (NY): United Nations; 2011. Retrieved august 17, 2011, from http://esa.un.org/unpd/wpp/index.htm

3. Reviewer #1:

(3) The statement "Items about the use of tan assessment module, the chat…" in subsection 3.2 (page 9, row 20),
there is a mistake on it.
(4) The statement "As illustrated in Table 1, two substantially…" in subsection 4.1 (page 10, row 38), there is a mistake on it.
(7) The statement "Table 3 provides an overview of the path coefficients." in subsection 4.3 (page 14, row 10), there is a mistake on it.
(12) The statement "…school teachers, un understudied group of LMS users within educational research." In section 6 (page 16, row 30), there is a mistake on it.

Reaction on comment:

We thank reviewer #1 for the remarks on our typos, which we adjusted in the manuscript.

4. Reviewer #1:

(5) Table 3 needs to realign for more concisely.

Reaction on comment:

It seems something went wrong at the moment our text document was exported from the Word processor to a PDF-document. This problem has been solved in our manuscript.

5. Reviewer #1:

(6) It needs to conduct a clear explain of "Why table 2 contains the nine items about instructional use of LMS, but
table 3 contains only seven items?"

Reaction on comment:

Table 2 contains 9 **items** on which an exploratory factor analysis (EFA) was performed in order to validate the psychometric quality of our research instrument. As mentioned in the article, they illustrate how 2 different **variables** (informational use and communicational use) can be distinguished within these 9 **items**.
On the other hand, Table 3 summarizes the means, standard deviations and reliability of all

variables, as well as all the correlations between these **variables**.

We changed both titles of table 2 and table 3 to underscore the difference between the item and variable level and the specified variables.

Revisions made on table 2 (page 12)

Table 2 (old): exploratory factor analysis of the dependent variable
Table 2: exploratory factor analysis of the dependent variable (9 remaining items)

Revisions made on table 3 (page 13)

Table 3 (old): Means, standard deviations, Cronbach's alpha (α) and correlations of constructs
Table 3: Means, standard deviations, Cronbach's alpha (α) of all variables and their correlations

6. Reviewer #1:

(8) Subsection 2.4 in page 6, row 58-60, "In this respect, we expect that a teacher with a higher level of technological innovativeness will more readily use an LMS, and this up to the communicational level". It needs to conduct a clear explain of "Why personal innovativeness towards IT can't positively affects informational use?"
(9) Subsection 2.5 and 2.6 in page 7, it also needs to conduct a clear explain of "Why both internal support towards ICT and experience can't positively affects communicational use?"

Reaction on comment:

We will first explain why we did not include the relations mentioned above. Next, we will present the changes we made in our manuscript.

We want to emphasize that our model does assume that personal innovativeness affects informational use, however indirectly via perceived ease of use and perceived usefulness; and that both internal ICT support and experience affect communicational use, however indirectly via informational use. Since we did not find enough grounded arguments to expect these direct relations mentioned by reviewer #1 and we strive for a parsimonious model, we did not include them. We believe our choice can be justified, as it was argued by Burnham and Anderson (2002) that "a parsimonious model, representing a well-defended scientific hypothesis, aids in our understanding of the system of interest" (p. 438). When structural equation modeling is applied, Cheng (2001) added "in order to achieve the goodness-of-fit indices and obtain the 'best fitting' model, unexpected relationships between indicators of different variables or between indicator and a non-underlying variable have to be minimized" (p. 651).

Malikowski, Thompson and Theis (2007) argued that instructors use an LMS to transmit information to students, but hardly use features that allow them to create interactive learning activities. They state that "this reflects an incremental approach in using CMS features because instructors are familiar with transmitting information—from experience in distributing syllabi, writing manuscripts, using PowerPoint presentations, or attaching files to e-mail messages" (p.152). These findings underscore the direct relation from experience to informational use, but also clearly stress that (prior) experience (with distributing syllabi, writing manuscripts or using PowerPoint presentations) is a much better and more credible predictor for informational use than personal innovativeness towards IT.

The meta-analysis by Malikowski, Thompson and Theis (2007) also explains why we didn't include a direct relation between experience and communicational use. Before the LMS was introduced, e.g. teachers were already handing out syllabi. When the LMS arrived, paper versions of syllabi were replaced by uploading syllabi in a digital format. But before the LMS, teachers weren't performing actions like working with wiki's or creating computer-based instruction. As there is no (prior)

experience, we don't foresee a direct relation from experience to communicational use.

As mentioned in our manuscript, Schillewaert et al. (2005) reported "that it is not only possible to distinguish a direct relation between personal innovativeness towards IT and technology adoption, but also an indirect relation through perceived usefulness and perceived ease of use". Furthermore, we argued that Schillewaert et al. (2005) concurred with Van Raaij and Schepers (2008) that "being used to adapting to new systems and processes might reveal the usefulness and ease of use more quickly to an innovative person than to a non-innovative person". These statements clearly underscore a direct and an indirect relation. In our research, we reasoned an indirect relation from personal innovativeness towards IT to a) informational use via perceived ease of use and perceived usefulness, and b) to communicational use via informational use.

Given our reasoning that a) experience has been a better predictor for informational use than personal innovativeness towards IT b) teachers can't relate to prior experiences concerning communicational LMS use, and c) Schillewaert et al. (2005) stated there is a direct relation from personal innovativeness towards IT towards use; we believe there is a direct relation between personal innovativeness towards IT and communicational use. We also would like to add that, given the definition of personal innovativeness towards IT by Agarwal & Prasad (1998) as "the willingness of an individual to try out any new information technology", wiki's, weblogs or learning paths can be considered as new information technology, whereas distributing documents or posting announcements are just 'online translations' of old and familiar actions.

The flowchart (more detailed information can be found further on in this revision letter) by Malikowski, Thompson and Theis (2007) suggests a sequence of adoption. The features of the lowest level (Level 3) "will be used by most instructors only after they have used features in the Level 2 categories. The lowest level in the flowchart suggests new features will be adopted when instructors identify learning needs that can be met with additional CMS features" (p. 169). In this respect, we can imagine internal ICT support could help teachers linking learning needs to LMS features. However, Tondeur, Valcke, and van Braak (2008) found that "Since 2002, all schools in Flanders receive financial support to appoint an ICT coordinator. Their task profile includes both pedagogical and technical support tasks as well as an advisory function to the school board. However, in reality most of the time is devoted to technical aspects of ICT-coordination (Ministry of the Flemish Community, Department of Education 2005)" (p. 498). Given this observation by the Department of Education of the Ministry of the Flemish Community almost no pedagogical support is given, and only focused on technological issues, we concluded that the type of support given to teachers today is not sufficient to expect that this support will lead to more communicational use.

References

Burnham, K.P. & Anderson, D.R. (2002). *Model selection and multimodel inference: a practical-theoretic approach* (2nd ed.). New York: Springer-Verlag.

Cheng, E.W.L. (2001). SEM being more effective than multiple regression in parsimonious model testing for management development research. *Journal of Management Development, 20,* 650–667.

Ministry of the Flemish Community, Department of Education. (2005) Education in Flanders. The Flemish Educational Landscape in a Nutshell. Van In, Lier, Belgium.

Revisions made on 2.6 Experience (page 8-9)

2.6 Experience

Though experience is often mentioned as a mediating factor, Sun and Zhang (2006) stressed that there is a need for an operational definition of experience that fits particular professional knowledge domains. Building on their work, we conceptualize experience in this study as the number of years teachers have worked with an LMS.

According to King and He (2006), the level of experience is the best-studied variable in TAM, consistently reiterating the difference between inexperienced and experienced users. As a result, we assume that experienced teachers will use the LMS more for informational use than inexperienced

teachers.
Malikowski et al. (2007) argued that instructors use an LMS to transmit information to students, but hardly use features that allow them to create interactive learning activities. They state that "this reflects an incremental approach in using CMS features because instructors are familiar with transmitting information—from experience in distributing syllabi, writing manuscripts, using PowerPoint presentations, or attaching files to e-mail messages" (p.152). Venkatesh et al. (2000) reasoned that as direct experience with technology increases overtime, individuals have a better assessment of the benefits and costs associated with the use of technology. Applying the latter to the present research context, we expect that the level of experience will influence perceived ease of use and the informational use of an LMS.
H5a: Experience positively affects perceived ease of use.
H5b: Experience positively affects informational use.

It was argued by Burnham and Anderson (2002) that "a parsimonious model, representing a well-defended scientific hypothesis, aids in our understanding of the system of interest" (p. 438). When structural equation modeling is applied, Cheng (2001) added "in order to achieve the goodness-of-fit indices and obtain the 'best fitting' model, unexpected relationships between indicators of different variables or between indicator and a non-underlying variable have to be minimized" (p. 651).
Bringing together the available empirical and theoretical base in relation to the use of LMS, we can draw the following conceptual and parsimonious model.

Added to References (page 16-19)

Cheng, E.W.L. (2001). SEM being more effective than multiple regression in parsimonious model testing for management development research. *Journal of Management Development*, 20, 650–667.

Burnham, K.P. & Anderson, D.R. (2002*). Model selection and multimodel inference: a practical-theoretic approach (2nd ed.).* New York: Springer-Verlag.

7. Reviewer #1:

(10) Page numbers are lacking (I invented my own numbering scheme, starting with page 1 for the first page after
the abstract.)

Reaction on comment:

We apologize to reviewer #1 for this inconvenience and added page numbers.

8. Reviewer #1:

(11) Please ensure that the format of citation in text self-consistent in manuscript.

Reaction on comment:

We reread our manuscript and adjusted citations.

9. Reviewer #2:

The research study has two clear goals: to investigate types of LMS use (differentiating between Informational and Communicational use); and to develop a predictive model of use. I believe that the study is quite robust and useful in terms of the second goal and has implications for practices where secondary school managers are encouraging teachers to use LMSs. I am not sure that the findings related to the differentiation of use, nor the testing of the hypothesis that Informational use is a precursor of communicational use, are useful or provide any novel insights worth reporting. I would restructure the study and just focus on the predictors to 'generic use' of LMS and do further work on the different types of use before publishing further in this area.

Reaction on comment:

We thank reviewer #2 to qualify the main part of our study as robust and useful. We also understand the remarks made on our decision to differentiate between different forms of LMS-use, but after careful consideration, we are still convinced this distinction should be made. However, the remark of reviewer #2 convinced us to strengthen our arguments. We will list our arguments first and then indicate (see revisions made) how we extended our article with substantial clarifications.

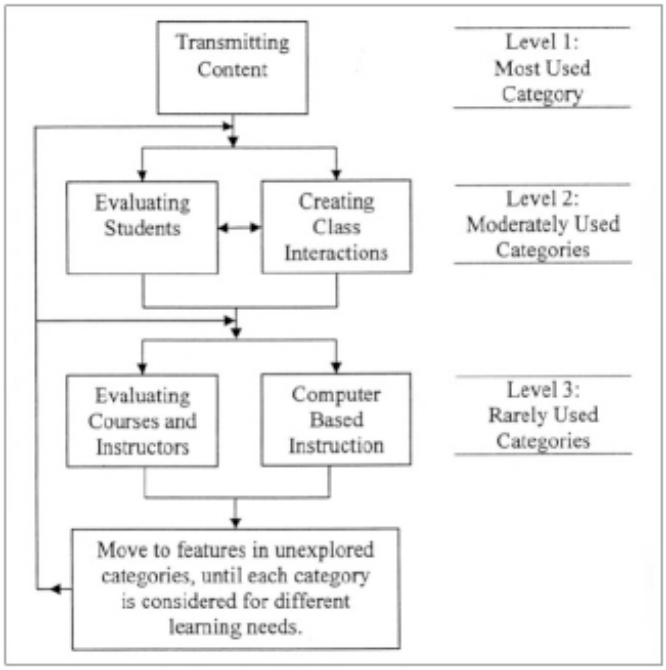
Empirical and theoretical evidence

Our first argument is based on theoretical and empirical evidence. This study was preceded by a prior study (given the blind review, authors as requested not mentioned, XXXX). Our main findings were that secondary school teachers use their LMS above all for informational purposes, but hardly for communicational purposes. A research report by Sclater (2008) from the Open University UK reported similar findings: “the communication features of LMSs are poorly utilized in most institutions, the LMSs being used primarily as storage facilities for lecture notes and PowerPoint presentations” (p. 2). Another similar conclusion was published earlier by Nijhuis & Collis (2003). In their article, researching instructor contributions stored in their faculty’s web system during an academic year, they concluded that LMSs were used most frequently for storing lecture notes and course information, but instructors almost neglected all of the remaining LMS features.

Different forms of LMS usage can be found within the literature. We listed Dabbagh and Kitsantas (2005), Dabbagh and Bannan-Ritland (2004) and Lonn and Teasley (2009) in our manuscript, but choose to build on the work of Hamuy and Galaz (2010) and Silvio et al. (2004). Their research focuses on empirical evidence and theoretical arguments. In their empirical study, Guthrie and Prats-Planagumà (2010), found empirical evidence for differentiating between informational and communicational use within LMS’ as proposed by Hamuy and Galaz (2010).

In their study, based on a meta-analysis of several LMS-studies, involving data from more than 40 North-American universities and 2000 different courses, Malikowski, Thompson and Theis (2007) suggested to differentiate between five categories of LMS-use: (a) transmitting course content; (b) evaluating students; (c) evaluating courses and instructors; (d) creating class discussions and (e) creating computer-based instruction. Categories were grouped in three levels and integrated in a flowchart. Research categories with the most used CMS features appear near the top and are labeled as “Level 1.” Research categories that have been adopted moderately often are in the middle and labeled as “Level 2.” The least adopted CMS features are at the bottom and labeled as “Level 3.”

The flowchart suggests how instructors adopt CMS features Malikowski, Thompson and Theis (2007).



When we compare this model with table 1 in our article, level one by Malikowski, Thompson and Theis (2007) is almost identical to the informational level of Hamuy and Galaz (2010), level two and three to the communicational level of Hamuy and Galaz (2010).

As can be seen in the flowchart of categories, transmitting content comes first. As Malikowski, Thompson and Theis (2007) clarify: “The levels and arrows are based on research findings summarized in the previous section of this article. Since CMSs are used by most instructors to transmit content, this category was placed at the top of the flowchart, at Level 1, suggesting that instructors transmit content when they first use a CMS. CMS features for evaluating students or creating discussions are adopted much less often than transmitting content, so the flowchart suggests categories containing these features are adopted after instructors have transmitted content in a CMS. The lowest positioned categories on the flowchart contain CMS features that instructors infrequently use, which are student surveys and computer based instruction. The flowchart suggests these features will be used by most instructors only after they have used features in the Level 2 categories. The lowest level in the flowchart suggests new features will be adopted when instructors identify learning needs that can be met with additional CMS features” (p. 169).

We are convinced that adding this research to our article not only adds evidence to the differentiation of LMS-use, but also to our hypothesis and results that informational use is a precursor of communicational use.

Validity

The second argument we would like to suggest in keeping the differentiation of LMS-use in this paper is the fact that exploring these different types of use within a TAM-framework provides a contribution to the existing literature. Limiting this study to a generic TAM study would of course validate earlier research, however, by differentiating between the two types of LMS-use (informational and communicational use) we are delivering a unique opportunity to broaden and increase the TAM-framework and the operationalization of LMS-use. In this respect, this differentiation does provide novel insights, since it goes further then the mere replication and validation of earlier theories and experiments.

Furthermore, changing our research design would go against the remarks of reviewer #3.

Revisions made on 2.1 Research model (page 3 - 5)

The “Informational” level is defined by Hamuy & Galaz (2010) as contents published by users in the LMS, the “Communicational” level is defined as the processes that foster the exchange of these contents between LMS users. With this categorization Hamuy & Galaz (2010) could track down different LMS usage by students and teachers. They observed an emphasis on Informational LMS use (89%). Similar results were reported by Nijhuis and Collis (2003), De Smet and Schellens (2009), Guthrie and Prats-Planagumà (2010) and by Malikowski, Thompson and Theis (2007), whose research will be briefly described in section 2.2 below.

Revisions made on 2.2 The primacy of Informational LMS use (page 5 - 6)

West, Waddoups, and Graham (2006) found that teachers usually don’t use all LMS features right from the start. They rather experiment with individual features that directly address particular instructional goals or an organizational need. When LMS features meet these goals or needs, some teachers start experimenting with other LMS functionalities. This is congruent with early technology innovation research. Nambisan, Agarwal and Tanniru (1999) found e.g., that users need to acquire a basic factual knowledge level about technology before they are able to move on. This critical need for an initial – basic knowledge – phase , has been extensively researched within the innovation diffusion literature to better understand emergent IT use (Ahuja and Thatcher, 2005). In this context, Robinson, Marshall, and Stamps (2005) argue that innovative individuals focus on news about the technology of their interest. Having worked with a variety of similar technologies, they become able to draw parallels and become capable to adapt quickly to other – more advanced – systems. In educational contexts, Tondeur et al. (2008) found that teacher’s adoption of ICT first focused on “basic computer skills”. In addition they observed that “availability of computers in the classroom” was a critical precursor of later adoption of ICT as a learning tool.

Malikowski, Thompson and Theis (2007) distinguish three levels of adoption with respect to CMS features: Level 1, consisting of the most commonly used CMS features such as transmitting course content; Level 2, comprising features with moderate adoption such as evaluating students, courses and instructors; and Level 3, including the least adopted features like creating class discussions and computer-based instruction. Level 1 features can be seen as features focusing on what Hamuy and Galaz (2010) refer to as the informational level, while level 2 and 3 correspond with the communicational level (Hamuy & Galaz, 2010). Between these levels, Malikowski, Thompson and Theis (2007) found a sequence of adoption decisions with Level 1 on top, Level 2 in the middle and Level 3 at the bottom. They concluded that Level 1 or informational use “was placed at the top of the flowchart, suggesting that instructors transmit content when they first use a CMS. CMS features for evaluating students or creating discussions are adopted much less often than transmitting content, so the flowchart suggests categories containing these features are adopted after instructors have transmitted content in a CMS. The lowest categories on the flowchart contain CMS features that instructors infrequently use, which are student surveys and computer based instruction. The flowchart suggests most instructors will use these features only after they have used features in the Level 2 categories. The lowest level in the flowchart suggests new features will be adopted when instructors identify learning needs that can be met with additional CMS features” (p. 169).

All these observations and arguments have in common that a basic usage level of specific technologies, is required to foster the adoption of more advanced types of technology use. Therefore, within the context of the present study about LMS usage, we expect informational use of the LMS to be a precursor of communicational use.

H1: Informational use will be a precursor of communicational use.

Revisions made on References (page 18-22)

Guthrie, V. & Prats-Planagumà L. (2010). Testing Delivery Systems in Transnational Virtual Learning: The Vocational Management Training for the European Tourism Industry (VocMat) Case Study. *Information Technology in the Tourism Industry*, 2, 22–29.

Malikowski, S. R., Thompson, M. E., & Theis, J. G. (2007). A model for research into course management systems: Bridging technology and learning theory. *Journal of Educational Computing Research*, 36, 149–173.

Nijhuis, G. G., & Collis, B. (2003). Using a web-based course-management system: an evaluation of management tasks and time implications for the instructor. *Evaluation and Program Planning*, 26, 193–201.

Sclater, N. (2008). *Web 2.0, Personal Learning Environments, and the Future of Learning Management Systems*. EDUCAUSE Center for Applied Research; Research Bulletin, 2008(13).

9. Reviewer #3:

This is well developed theoretically and an excellent research design. Substantial support for your research choices. Very thorough literature review, excellent sampling and analysis. Conclusions tightly connected to the findings. Please review for a few typos related to punctuation.

Reaction on comment:

We would like to thank reviewer #3 for the positive feedback. Extra effort with special focus on punctuation had been undertaken in order to correct typos.

***Title Page -- anything identifying the author should be on this page.**

Researching instructional use and the technology acceptation of Learning Management Systems by secondary school teachers

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Abstract: The aim of this large-scale study was to understand the technology acceptation of learning management systems (LMS) by secondary school teachers and to investigate the instructional use of LMS, distinguishing between informational use and communicational use. The predictive model further includes: perceived usefulness, perceived ease of use, subjective norm, personal innovativeness in the domain of information technology, experience and internal ICT support at school level. Data were collected from 505 Flemish secondary school teachers. After performing satisfactory reliability and validity checks, the study was able to support all relationships among the 9 variables. Informational use was found to be a precursor for communicational use, perceived ease of use of the LMS is the strongest predictor in LMS-acceptation. Internal ICT support has a direct effect on the informational use of the LMS and on subjective norm. Implications stress that secondary school managers in education should take into account the importance of a teachers' efforts and performance perceptions and the direct and indirect impact of internal ICT support on LMS adoption.

Keywords: interactive learning environments, learning management systems, secondary education, technology adoption.

1. Introduction

1.1 Technology acceptance

Learning Management Systems (LMS; also referred to as Virtual Learning Environments, Digital Learning Environments, Course Management Systems or Electronic Learning Environments) are web based applications, running on a server and accessible with a web browser from any place with an Internet connection. LMS give educators tools to create online course websites, and provide access to learning materials (Cole & Foster, 2008). LMS find their origins in the late nineties. The current commercial market leader Blackboard was founded in 1997. Their open source opponent Moodle was established in 1999 (Delta Initiative, 2009). At the start, individual educators also adopted "home-made" solutions, combining a number of basic tools such as navigation, text forums, roles, etc. By 2004, most universities felt a need to centralize their elearning systems and moved to a single, centrally hosted and supported environment (Weller, 2010). Today, most LMS provide a number of basic features and a set of specific tools and functionalities to support learning.

Recent research shows that there has been a permanent market rise in the use of LMS in higher (Kember, McNaught, Chong, Lam & Cheng, 2010) and secondary education (De Smet & Schellens, 2009; Pynoo, Devolder, Tondeur, van Braak, Duyck & Duyck, in press). The last Educause Report confirms that almost 90% of all responding American universities and colleges reported the availability of an LMS and related support for faculty and students (Arroway, Davenport, Xu & Updegrove, 2010).

Despite this high adoption rate, little is known how LMS benefit learning (Koszalka & Ganesan, 2004), how the use of these systems is related with teacher and student perceptions about teaching and learning (Lonn & Teasley, 2009), or about the technology acceptance of LMS (Van Raaij & Schepers, 2008; Sánchez & Hueros, 2010). In the current article, the objective is to research the reasons behind the technology acceptation of learning management systems (LMS) by secondary school teachers, and to investigate the instructional use of the LMS-use within this group of teachers.

Early social theories, like the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975), introduced descriptive models to study individuals' intended behavior. According to this theory, someone's behavior is primarily determined by his or her intention to perform that behavior. This intention is, in turn, influenced by two factors, namely the person's attitude toward performing this behavior and the perceived social pressure to engage in action.

In line with the Technology Acceptance Model (TAM) of Davis (1989), intended behavior involves two primary and direct related predictors: perceived usefulness (e.g., using a specific technology will increase their job performance) and perceived ease of use (e.g., using a specific technology will not require much effort).

To predict the acceptance of new technologies, TAM and its successor TAM2 (Venkatesh & Davis, 2000) received a lot of attention (Sun & Zhang, 2006). Comparative studies confirm the supremacy of the TAM over other intentional behavior models and theories (Matthieson, 1991). Legris, Ingham, and Collerette (2003) concluded that TAM has been widely adopted with different technologies and in various contexts and successfully predicted 40% of a system's use.

1.2 LMS acceptance

TAM-based models have already been used in a number of studies to understand and predict LMS acceptance in non-educational (Ong et al, 2006) and educational settings (Ngai et al., 2007; Sanchez & Hueros, 2010). Ngai, Poon, and Chan (2007), for example, studied the adoption of WebCT (a LMS acquired by Blackboard Inc in 2006) by university students with a TAM-based model, which was enriched with the variables technical support and attitude. As explained by Davis (1989), attitude is the degree to which the user is interested in specific systems. They found that perceived ease of use and usefulness were the dominant factors to predict LMS usage. Van Raaij and Schepers (2010), who studied the acceptance of the LMS by 45 Chinese managers enrolled in an executive MBA program, added that TAM does hold across cultures.

In the present study, a comparable TAM framework was adopted as in earlier studies about LMS acceptance (Van Raaij & Schepers, 2008; Sánchez & Hueros, 2010), but the framework was extended with additional variables to increase and broaden the validity. We focus in this extended model on the self-reported use of the LMS and not on the intentions for future use, as done in the majority of TAM-studies. Schillewaert, Ahearne, Frambach, and Moenaert (2005) and van Raaij and Schepers (2008) argued that there is no further need to focus on "intentions to use" the LMS, because the technology is already used on a daily base.

2. Theoretical development

2.1 Research model

The current research model is based on TAM2, an extended version of TAM enriched with the variables perceived usefulness of LMS, perceived ease of use of LMS and subjective norm. In the past, these TAM2 variables were not able to fully predict a system's use; therefore a search for additional factors was required (Ong et al., 2003). Sun and Zhang (2006) state in this context that TAM studies call "for the inclusion of

additional factors that reflect real world settings and conditions" (p. 55) and "for more research attention to individual and contextual factors" (p.54). Tondeur, Valcke & van Braak (2008) reasoned that in this brand of research, teacher and school characteristics should be considered.

In this study we examine how secondary school teachers use their LMS. We scrutinized the functionalities available in the three most often used LMS in our target group, i.e. Dokeos, Blackboard and Smartschool (De Smet & Schellens, 2009). The following functionalities were included: document publishing (the teacher uploads documents such as presentations, course documents, videoclips, etc.), announcements (the teachers send announcements or messages, that appear on the platform and/or are sent to the student's mailbox), uploading or publishing exercises (equal to document publishing, but specifically for exercises), receiving student products (the student uploads documents to be downloaded by peers and/or the teacher), assessment modules (student assignments with possibility to get feedback from teacher), chat (synchronous communication), learning path (road map for learners), forum (asynchronous communication environment), wiki (type of website, mostly powered by wiki software, that allows the creation of interlinked websites), agenda, reservations module (material or classrooms) and student tracking module (absences or grading).

In earlier research, LMS-use has been characterized in alternative ways. Dabbagh and Kitsantas (2005) and Dabbagh and Bannan-Ritland (2004) distinguished between the following functionalities and tools: collaborative and communication tools (e-mail, discussion forums, and chat tools), content creation and delivery tools (upload course content and tools to access them), administrative tools (course information, functions, interactions, and contributions) and assessment tools (assessment, tracking, posting grades etc.). Lonn and Teasley (2009) made a distinction between: materials management (organize course content, such as syllabuses, lecture slides, and exercises), interactive teaching (communication between the teachers and their students via announcements or assignments) and peer learning (peer review, group projects, and student wikis). Hamuy and Galaz (2010) differentiate between two broad types of LMS functionalities. These two categories build further on the five levels of LMS interactions as proposed and applied in a UNESCO/IESALC's cross-national research (Silvio et al., 2004). Each consecutive LMS level allows for a deeper level of interaction.

Table 1: Adaptation of the five levels of LMS interaction by Hamuy and Galaz (2010)

	Informational Level
Presence	Delivery of data or information that is limited to the syllabus of the course
Informative interaction	Offering some additional data on the operative and practical processes of a course, such as calendar and announcements
Consultative interaction	Accessing information without feedback possibilities, such as downloading or linking readings, presentations and statistics
	Communicational Level
Communicational interactivity	Allowing the user to access spaces of synchronous or asynchronous communication
Transactional Interaction	Making complex interactions that support social construction of knowledge, such as forums, assessments or chats

The "Informational" level is defined by Hamuy & Galaz (2010) as contents published by users in the LMS (p. 171), the "Communicational" level is defined as the processes that foster the exchange of these contents between LMS users (p. 171). With this categorization Hamuy & Galaz (2010) could track down different LMS usage by students and teachers. They observed an emphasis on Informational LMS use (89%). Similar results were reported by Nijhuis and Collis (2003), De Smet and Schellens (2009), Guthrie and Prats-Planagumà (2010) and by Malikowski, Thompson and Theis (2007), whose research will be briefly described in section 2.2 below.

2.2 The primacy of Informational LMSuse

West, Waddoups, and Graham (2006) found that teachers usually don't use all LMS features right from the start. They rather experiment with individual features that directly address particular instructional goals or an organizational need. When LMS features meet these goals or needs, some teachers start experimenting with other LMS functionalities. This is congruent with early technology innovation research. Nambisan, Agarwal and Tanniru (1999) found e.g., that users need to acquire a basic factual knowledge level about technology before

they are able to move on. This critical need for an initial – basic knowledge - phase, has been extensively researched within the innovation diffusion literature to better understand emergent IT use (Ahuja and Thatcher, 2005). In this context, Robinson, Marshall, and Stamps (2005) argue that innovative individuals focus on news about the technology of their interest. Having worked with a variety of similar technologies, they become able to draw parallels and become capable to adapt quickly to other– more advanced - systems. In educational contexts, Tondeur et al. (2008) found that teacher's adoption of ICT first focused on "basic computer skills" (p. 498). In addition they observed that "availability of computers in the classroom" (p. 498) was a critical precursor of later adoption of ICT as a learning tool.

Malikowski, Thompson and Theis (2007) distinguish three levels of adoption with respect to CMS features: Level 1, consisting of the most commonly used CMS features such as transmitting course content; Level 2, comprising features with moderate adoption such as evaluating students, courses and instructors; and Level 3, including the least adopted features like creating class discussions and computer-based instruction. Level 1 features can be seen as features focusing on what Hamuy and Galaz (2010) refer to as the informational level, while level 2 and 3 correspond with the communicational level (Hamuy & Galaz, 2010). Between these levels, Malikowski, Thompson and Theis (2007) found a sequence of adoption decisions with Level 1 on top, Level 2 in the middle and Level 3 at the bottom. They concluded that Level 1 or informational use "was placed at the top of the flowchart, suggesting that instructors transmit content when they first use a CMS. CMS features for evaluating students or creating discussions are adopted much less often than transmitting content, so the flowchart suggests categories containing these features are adopted after instructors have transmitted content in a CMS. The lowest categories on the flowchart contain CMS features that instructors infrequently use, which are student surveys and computer based instruction. The flowchart suggests most instructors will use these features only after they have used features in the Level 2 categories. The lowest level in the flowchart suggests new features will be adopted when instructors identify learning needs that can be met with additional CMS features" (p. 169).

All these observations and arguments have in common that a basic usage level of specific technologies, is required to foster the adoption of more advanced types of technology use. Therefore, within the context of the present study about LMS usage, we expect informational use of the LMS to be a precursor of communicational use.

H1: Informational use will be a precursor of communicational use

2.3 Perceived usefulness, perceived ease of use and subjective norm

Perceived usefulness is defined by Davis (1989) as "the degree to which a person believes that using a particular system will enhance job performance" (p. 320). In most TAM-studies, perceived usefulness has been the strongest predictor for behavioral intention. King and He (2006) therefore conclude their meta-analysis with the statement: "if one could measure only one independent variable, perceived usefulness would clearly be the one to choose" (p. 746). But even if users think their performance will benefit from technology usage, they do not necessarily actively engage with the technology. Davis (1989) explains this as follows: "they may, at the same time, believe that the system is too hard to use and that the performance benefits of usage are outweighed by the effort of using the application" (p. 320). In this respect, the variable perceived ease of use plays a role. It refers to an individual's believe that using a system or technology is free of effort. The third variable in our study, subjective norm, refers to the social influence of important others (Ma et al., 2005). Though Davis (1989) did not include social influence as a direct determinant of behavioral intention, Venkatesh and Davis (2000) reconsidered this variable in the TAM2 model, especially in settings where a particular technology usage is mandatory. Van Raaij and Schepers (2008) refer in this context to LMS environments when they have to be used in order to complete the course. This reconfirms the position of subjective norm in the present study.

The traditional TAM components in our model lead to four hypotheses.

H2a: Perceived usefulness positively affects informational use

H2b: Perceived ease of use positively affects informational use

H2c: Perceived ease of use positively affects perceived usefulness

H2d: Subjective norm positively affects perceived usefulness

2.4 Personal innovativeness towards IT

Personal innovativeness towards IT is defined as the willingness of an individual to try out any new information technology (Agarwal & Prasad, 1998). Van Raaij and Schepers (2008) regard personal innovativeness as "a form of openness to change" (p. 841). They concur with Schillewaert et al. (2005) that "being used to adapting to new systems and processes might reveal the usefulness and ease of use more quickly to an innovative person than to a non-innovative person" (p. 843). Lewis, Agarwal, and Sambamurthy (2003) add that available research consistently points at personal innovativeness towards IT as an important predictor of technology acceptance.

As reported by Schillewaert et al. (2005), it is not only possible to distinguish a direct relation between personal innovativeness and technology adoption, but also an indirect relation through perceived usefulness and

perceived ease of use. They concluded that a person's predisposition towards technology plays an important role. They also stress that some people have a prejudice against technology. This is also observed in educational contexts, where this variable can help to explain the non-adoption of LMS by 19% of teachers, despite an LMS being available at school (De Smet & Schellens, 2009). In this respect, we expect that a teacher with a higher level of technological innovativeness will more readily use an LMS, and this up to the communicational level.

H3a: Personal innovativeness towards IT positively affects communicational use

H3b: Personal innovativeness towards IT positively affects perceived ease of use

H3c: Personal innovativeness towards IT positively affects perceived usefulness

2.5 Internal ICT support

Sánchez and Hueros (2010) indicate that technical support is one of the most important factors in the acceptance of educational technology. Also Ngai, Poon, and Chan (2007) reported a strong - indirect - effect of technical support on attitude, thus underscoring the importance of user support and training on the perceptions of users and eventually their use of the system. This is confirmed by the significant and strong association between teacher perceptions of school-based ICT support and actual classroom use of ICT in the study of Tondeur, Van Keer, van Braak, and Valcke (2008). We can therefore assume that internal ICT support will influence the perceptions of the teachers and the use of the LMS.

H4a: Internal support towards ICT positively affects informational use

H4b: Internal support towards ICT positively affects subjective norm

2.6 Experience

Though experience is often mentioned as a mediating factor, Sun and Zhang (2006) stressed that there is a need for an operational definition of experience that fits particular professional knowledge domains. Building on their work, we conceptualize experience in this study as the number of years teachers have worked with an LMS.

According to King and He (2006), the level of experience is the best-studied variable in TAM, consistently reiterating the difference between inexperienced and experienced users. As a result, we assume that experienced teachers will use the LMS more for informational use than inexperienced teachers.

Malikowski et al. (2007) argued that instructors use an LMS to transmit information to students, but hardly use features that allow them to create interactive learning activities. They state that "this reflects an incremental approach in using CMS features because instructors are familiar with transmitting information—from experience in distributing syllabi, writing manuscripts, using PowerPoint presentations, or attaching files to e-

mail messages" (p.152). Venkatesh et al. (2000) reasoned that as direct experience with technology increases overtime, individuals have a better assessment of the benefits and costs associated with the use of technology. Applying the latter to the present research context, we expect that the level of experience will influence perceived ease of use and the informational use of an LMS.

H5a: Experience positively affects perceived ease of use

H5b: Experience positively affects informational use

Burnham and Anderson (2002) argued, "a parsimonious model, representing a well-defended scientific hypothesis, aids in our understanding of the system of interest" (p. 438). When structural equation modeling is applied, Cheng (2001) added, "in order to achieve the goodness-of-fit indices and obtain the 'best fitting' model, unexpected relationships between indicators of different variables or between indicator and a non-underlying variable have to be minimized" (p. 651). Bringing together the available empirical and theoretical base in relation to the use of LMS, we can draw the following conceptual and parsimonious model.

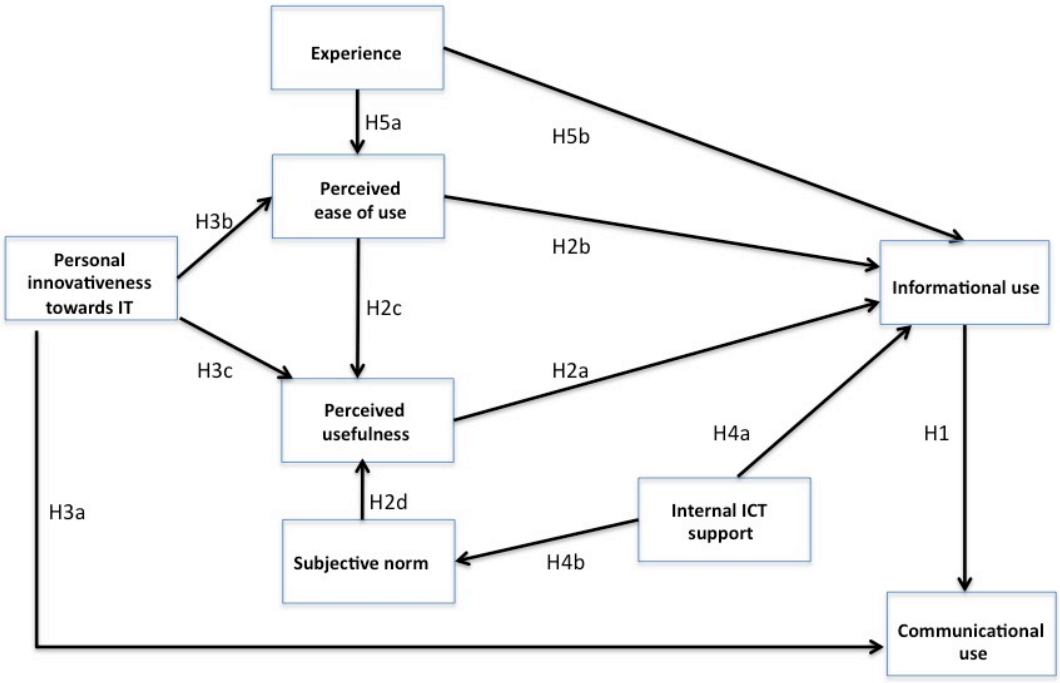

Figure 1. Theoretical model.

3. Method

3.1 Participants

Teachers were recruited as participants in the study via their schools. About seventy-two schools were willing to participate, counting for data from 505 teachers (41% response rate). This teacher sample was closely studied and found to be representative for the population, considering the variables "teaching levels in Flemish secondary education" (age level 12 to 18 years) and the type of secondary education (general, technical, and vocational). Respondents were given the option to fill out a paper and pencil version or an online version of the research instruments. Of the 505 questionnaires, 129 questionnaires were completed online, 376 were collected on paper. Post hoc, independent sample t-tests were used to check differences in answer patterns. No significant differences were found in response patterns between the two presentation formats.

All participating schools are situated in an urban area. Belgium, and the region of Flanders in particular, is one of the world's most urbanized countries in the world (United Nations World populations prospects, 2011). The sample consisted of 57.3% female respondents, which is close to the percentage (61.5%) in the population (Flemish Ministry of Education and Training, 2008). Teacher age range varied from 22 to 61 years, with an average age of 40 (SD = 10.5), teacher experience ranged from 1 to 42 years, with an average of 15 (SD = 10.8). We grouped participants based on the courses they teach and found out that 24% of them are language teachers (Dutch, French, English, German, Spanish, Latin, Greek etc.), 24% science teachers (math, biology, geography etc.), 18% reported teaching technical or vocational courses (electricity, haircut, hotel etc.) and 34% general courses (history, economy etc.).

3.2 Research instruments

A survey instrument was developed, consisting of two main sections. The first section focused on demographic (age and gender, coded 0 = female and 1 = male) and teacher related variables (such as number of years working as a teacher, grade, and teaching subject). The second section focused on the constructs as represented in the conceptual research model (Figure 1). Twelve items helped to determine the level of informational use and communicational LMS use. Items about document publishing, sending announcements, uploading or publishing exercises, receiving assignments, the agenda, student tracking, and the reservation module are linked to informational LMS-use. Items about the use of the assessment module, the chat environment, learning paths, a discussion forum and the wiki environment are linked to communicational LMS-use. Respondents were asked to indicate on a five point Likert scale to what extent they did actively use the particular LMS tool or functionality.

We adopted the four-item effort expectancy scale for perceived ease of use and the four-item performance expectancy for perceived usefulness of Venkatesh et al. (2003). For subjective norm, the original two-item scale based on Azjen and Fishbein (1980) is used. Personal innovativeness towards IT is assessed with the four-item scale from Agarwal and Prasad (1998). Internal ICT support is based on the four-item scale by Tondeur et al. (2008). All of these items are measured on a five-point Likert-scale, ranging from "totally disagree" (1) to "totally agree" (5). For all constructs, sum scores were calculated to evaluate the research model in figure 1.

4. Results

4.1 Psychometric quality of the research instruments

To check the psychometric quality of the instrument section focusing on the identification of types of instructional usage of an LMS, a two-step validation procedure was adopted. The sample (N = 505) was divided randomly into two sub-samples to evaluate the construct validity. IBM SPSS Statistics 18 was used to conduct an exploratory factor analysis (EFA) on the data of the first sub-sample (n = 253), using Maximum Likelihood estimation with oblique rotation. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.84, exceeding the suggested threshold for factor analysis of .6 (Tabachnik & Fidell, 2007). The Bartlett's test of sphericity was – as required – significant at .001 level. The number of factors was determined by a parallel analysis (O'Connor, 2000) and an examination of the scree-plot. On the basis of a first EFA, a two-factor solution was found, but three items (student follow-up, the reservation module and the agenda) were deleted due to communality values exceeding the treshold. A second EFA was performed on the 9 remaining items. A two-factor solution emerged, accounting for 60.5% of the common variance among the items, with eigenvalues of 4.01 and 1.43.

Table 2: exploratory factor analysis of the dependent variable (9 remaining items)

	Factor	
	Informational use	Communicational use
Document publishing	**0.931**	-.0107
Sending announcements	**0.719**	-0.032
Upload or publish excercises	**0.582**	0.183
Receive assignments	**0.485**	0.250
Assessment modules	-0.080	**0.800**
Chat	-0.110	**0.718**
Learning path	0.162	**0.635**
Forum	0.141	**0.565**
Wiki	0.093	**0.535**

As illustrated in Table 2, two substantially different constructs can be distinguished and are in line with the findings of Hamuy & Galaz (2010). Document publishing, sending announcements, upload or publish exercises and receive assignments can therefore be considered as indicators of an informational level in LMS usage. Assessment modules, chat, learning path, forum and wiki can be labeled as indicators of the communicational level in LMS usage.

Next, AMOS 17 was used to perform a confirmatory factor analysis (CFA) on the data of the second sub-sample (n = 252) and building on the two-factor structure resulting from the EFA. Error terms were not allowed to correlate. The following indices were calculated, taking into account criteria for the evaluation of goodness-of-fit indices (Byrne, 2001; Garson, 2009): Chi-square / degrees of freedom is less than 3 (2.11), the root mean square error of approximation (RMSEA) is higher than 0.05 (0.07), but lower than 0.08, reflecting a reasonable fit. The comparative fit index or CFI (0.97), the normed fit index or NFI (0.94) and the Tucker-Lewis index or TLI (0.94) reflect good fit values since they are close to 0.95. To conclude, on the base of the EFA and CFA, we can state that the instrument to determine instructional LMS use reflects good construct validity.

Construct validity was evaluated for the other variables measured with the instrument. Exploratory factor analysis (n = 253) using Maximum Likelihood estimation with oblique rotation was performed. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy is 0.86, exceeding the suggested threshold for factor analysis of .6 (Tabachnik & Fidell, 2007). The Bartlett's test of sphericity is – as required – significant at .001 level.The number of resulting factors is in line with the specific variables that was intended to be measured.

Table 3 summarizes the results of a reliability study (Cronbach's alpha). All values are close to 0.80, exceeding the threshold value (Nunnally, 1978). In addition, correlations between all variables are reported. A correlation matrix approach was applied (as illustrated in Table 3); most values are low among the different constructs. All mentioned values still suggest adequate validity of measurements.

Table 3: Means, standard deviations, Cronbach's alpha (α) of all variables and their correlations

	Mean	S.D	α	1	2	3	4	5	6	7
1. PU	3.44	0.85	0.90	1						
2. PEOU	3.39	0.91	0.88	0.39**	1					
3. SN	3.10	0.99	0.93	**0.41****	0.18**	1				
4. PIIT	3.03	0.99	0.90	0.26**	**0.40****	0.05	1			
5. ICTs	3.01	0.77	0.89	0.15**	0.15**	0.20**	0.12**	1		
6. Informational use	3.00	0.26	0.83	**0.42****	0.**46****	0.20**	0.23**	0.21**	1	
7. Communicational use	1.69	0.76	0.78	0.30**	0.24**	0.15**	0.23**	0.23**	**0.52****	1

Note: PU (perceived usefulness), PEOU (perceived ease of use), SN (subjective norm), PIIT (personal innovativeness towards IT) and ICTs (internal ICT support).

**. Correlation is significant at the 0.01 level

4.2 Path analysis research model

As stated earlier, the hypothetical relationships between the variables were tested on the base of structural equation modeling, using AMOS 17. The following fit indices were obtained. Chi-square /degree of freedom is slightly higher than 3 (3.11), the root mean square error of approximation (RMSEA) is close to 0.05 (0.65), suggesting a good fit. The comparative fit index or CFI (0.96), the normed fit index or NFI (0.94) and the Tucker-Lewis index or TLI (0.89) have values close to 0.9 or approach the benchmark of .95. All common goodness-of-fit indexes, exceeded or approached their respective common acceptance levels, suggesting that the research model exhibited an acceptable fit with the data. Properties of the causal paths, including standardized path coefficients and p-values are presented in Figure 2.

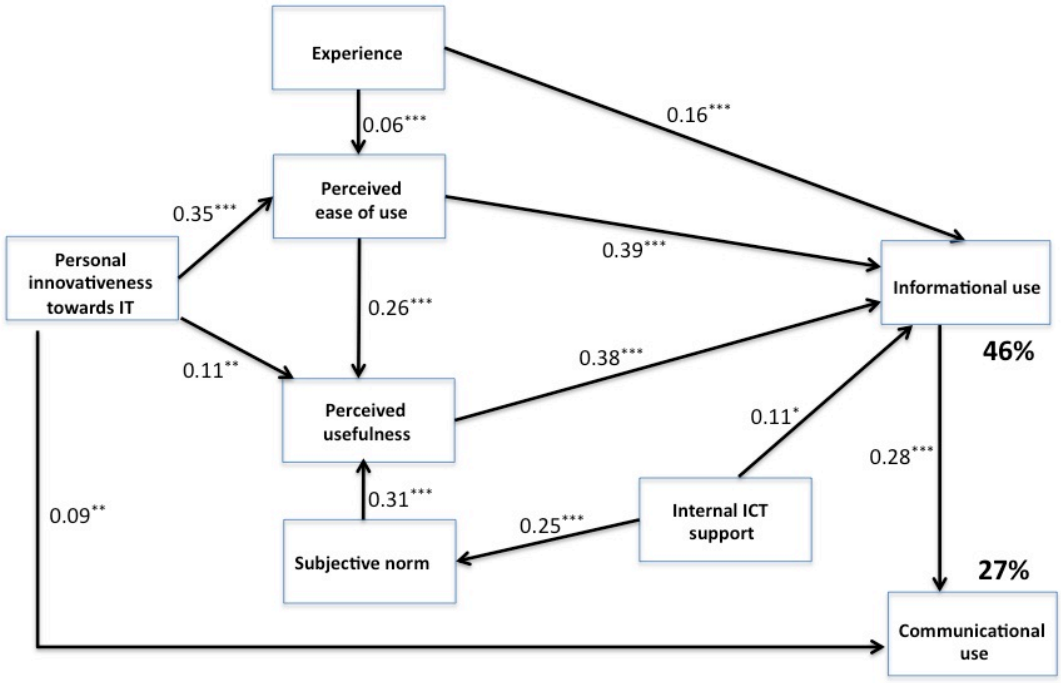

Figure 2. Model testing results

4.3 Hypothesis testing

Table 4: Summary of findings

Hypothesis	Effect	Coefficient	S.E.
H1	Informational use → communicational use	.28***	.024
H2	Perceived usefulness → informational use	.38***	.057
H3	Perceived ease of use → informational use	.39***	.053
H4	Perceived ease of use → perceived usefulness	.26***	.039
H5	Subjective norm → perceived usefulness	.31***	.033
H6	Personal innovativeness → communicational use	.09**	.030
H7	Personal innovativeness → Perceived ease of use	.35***	.038
H8	Personal innovativeness → perceived usefulness	.11**	.036
H9	Internal ICT support → informational use	.11*	.058
H10	Internal ICT support → subjective norm	.25***	.057
H11	Experience → perceived ease of use	.06***	.015
H12	Experience → informational use	.16***	.019

Note: * p < .05,**p < .01, *** p < .001

Table 4 provides an overview of the path coefficients. As to the assumption that informational use can be considered as a precursor for communicational use (H1), this hypothesis was supported (β = .28, p <.001).

The traditional TAM components appeared in four hypotheses. Perceived usefulness has a positive significant effect on informational use (H2, β = .38, p <.001). Perceived ease of use affects in a significant and positive way informational use (H3, β = .39, p <.001) and perceived usefulness (H4, β = .26, p <.001). Subjective norm is found to be a significant factor in determining perceived usefulness (H5, β = .31, p <.001). In line with other TAM studies, all hypotheses constituting the TAM-framework (H2, H3, H4 and H5) are confirmed.

The findings show that personal innovativeness in the domain of ICT has a direct positive effect on perceived ease of use (H7, β = .35, p <.001) and on perceived usefulness (H8, β = .11, p <.01). The effect on communicational use is significant but rather weak (H6, β = .09, p <.01).

Hypotheses H9 and H10 postulated the impact of internal ICT support on informational use and subjective norm. The analysis results show that internal ICT support has a positive significant effect on subjective norm (H10, β = .25, p <.001) and a significant effect on informational use (H9, β = .11, p <.05).

Experience has a significant effect on perceived ease of use (H11, β = .06, p <.001) and on informational use (H12, β = .16, p <.001).

The entire model is able to explain 46% of the variance in informational use and 27% of the variance in communicational use.

5. Discussion and implications

The present study aimed at identifying a number of significant determinants of types of LMS usage in secondary school teachers. The study contributes to the literature in a number of ways. First, the instructional use of LMS by secondary school teachers has been further explored and refined. Second, the study focused on the acceptance of the LMS by secondary school teachers, an understudied group. Further, the operationalisation of instructional use of an LMS into informational use and communicational use appeared to be valid. The research model is able to explain 46% of the variance in informational use and 27% of the variance in communicational use. As hypothesized, informational use seems to be a precursor of communicational use.

Furthermore we could successfully build on perceived usefulness, perceived ease of use and subjective norm as predictors from the original TAM-framework. Both perceived ease of use and perceived usefulness were found to have a strong effect on informational use. This means that in order for a secondary school teacher to use his LMS in an informational way, the usefulness and the ease of use of the LMS will be both taken into consideration. However, since we found a significant effect of perceived ease of use and subjective norm on perceived usefulness, we can additionally postulate that the ease of use of the LMS should be a critical initial variable, followed next by teachers' perception of the system's performance.

Another interesting result is the direct effect from internal ICT support on informational use and on subjective norm. This finding implies that supporting teachers at the school level will not directly influence personal use, but especially impact the opinion of important others. More important, as also indicated by Tondeur et al. (2008), the impact of internal (school) ICT support suggests that school level variables are important to understand technology acceptation. The adoption of the variable internal ICT support makes the TAM model congruent with the real – school - world setting and conditions as requested by Sun and Zhang (2006) and Ong et al. (2003). Also important is the positive effect of personal innovativeness on perceived ease of use. This suggests that innovative teachers are more easily convinced about the ease of use of the LMS. On the other

hand, the impact of innovativeness on usefulness was low, meaning that being innovative does not automatically result in a positive belief about a system's performance. This is also confirmed by the impact of personal innovativeness towards IT on communicational use. Being innovative is clearly not enough to start using an LMS for communicational use.

Based on the importance of the teacher's perception of the ease of use of their LMS and the availability of support, school managers or LMS coordinators can consider the following practical recommendations. Introduction sessions can be considered and manuals provided. If applicable, a decent translation of the LMS to the native language of the teacher and clarification on specific design characteristics should be foreseen. Some teachers aren't familiar with functionalities like the wiki or the learning path module. Best practices, continuous training and easy access to support will definitely be valuable for the teacher and might be that extra little thing to get them inspired.

6. Conclusion and limitations

The purpose of this paper was twofold: 1) developing a better understanding of secondary school teacher acceptation of a LMS and 2) studying the way this group of teachers actually uses an LMS in their instructional setting. Though the result, discussed above have clearly helped to attain our research goals, a number of limitations are to be considered.

First,instead of reported use of an LMS, we expect that using log files could lead to more accurate LMS related data. However this was not feasible practically in the current study, given the number of respondents and the difficulties in getting access to log files. Second, our research validates the categorization of LMS-interactions as defined by Hamuy & Galaz (2010). However, additional LMS functionalities, such as student tracking, the reservation module and the agenda had to be removed during the factor analysis procedure. Future research should continue to focus on the refining of LMS usage categories. Third, we were able to explain 46% of the variance in informational use, but only 27% of the variance in communicational use. Further research should focus on identifying additional variables to explain the adoption and implementation of communicational use. The latter could be for instance linked to beliefs of teachers about the types of learning strategies that are linked to the adoption of these LMS functionalities. Tondeur et al. (2008) could link specific teacher beliefs to specific types of ICT usage. The same could be done in the case of LMS adoption.

Nevertheless, the present study resulted in an acceptable structural model about the relationships between critical variables describing LMS adoption and usage. Moreover, this - large-scale - study involving secondary school teachers, focused on an understudied group of LMS users within educational research.

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Table(s)

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	Informational Level
Presence	**Delivery of data or information that is limited to the syllabus of the course**
Informative interaction	**Offering some additional data on the operative and practical processes of a course, such as calendar and announcements**
Consultative interaction	**Accessing information without feedback possibilities, such as downloading or linking readings, presentations and statistics**
	Communicational Level
Communicational interactivity	**Allowing the user to access spaces of synchronous or asynchronous communication**
Transactional Interaction	**Making complex interactions that support social construction of knowledge, such as forums, assessments or chats**

Table(s)

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	Factor	
	Informational use	Communicational use
Document publishing	**0.931**	-.0107
Sending announcements	**0.719**	-0.032
Upload or publish exercises	**0.582**	0.183
Receive assignments	**0.485**	0.250
Assessment modules	-0.080	**0.800**
Chat	-0.110	**0.718**
Learning path	0.162	**0.635**
Forum	0.141	**0.565**
Wiki	0.093	**0.535**

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	Mean	SD	α	1	2	3	4	5	6	7
1. PU	3.44	0.85	0.90	1						
2. PEOU	3.39	0.91	0.88	0.39**	1					
3. BN	3.10	0.99	0.93	0.41**	0.18*	1				
4. PIT	3.03	0.99	0.90	0.26**	0.49**	0.05	1			
5. ICDs	3.01	0.77	0.89	0.15*	0.15*	0.29**	0.12*	1		
6. Informational use	3.00	0.26	0.83	0.42**	0.46**	0.29**	0.23**	0.21**	1	
7. Communicational use	1.49	0.76	0.78	0.30**	0.24**	0.15*	0.23**	0.23**	0.52**	1

Table(s)

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Hypothesis	Effect	Coefficient	S.E.
H1	Informational use → communicational use	.28***	.024
H2	Perceived usefulness → informational use	.38***	.057
H3	Perceived ease of use → informational use	.39***	.053
H4	Perceived ease of use → perceived usefulness	.26***	.039
H5	Subjective norm → perceived usefulness	.31***	.033
H6	Personal innovativeness → communicational use	.09**	.030
H7	Personal innovativeness → Perceived ease of use	.35***	.038
H8	Personal innovativeness → perceived usefulness	.11**	.036
H9	Internal ICT support → informational use	.11*	.058
H10	Internal ICT support → subjective norm	.25***	.057
H11	Experience → perceived ease of use	.06***	.015
H12	Experience → informational use	.16***	.019

Figure(s)

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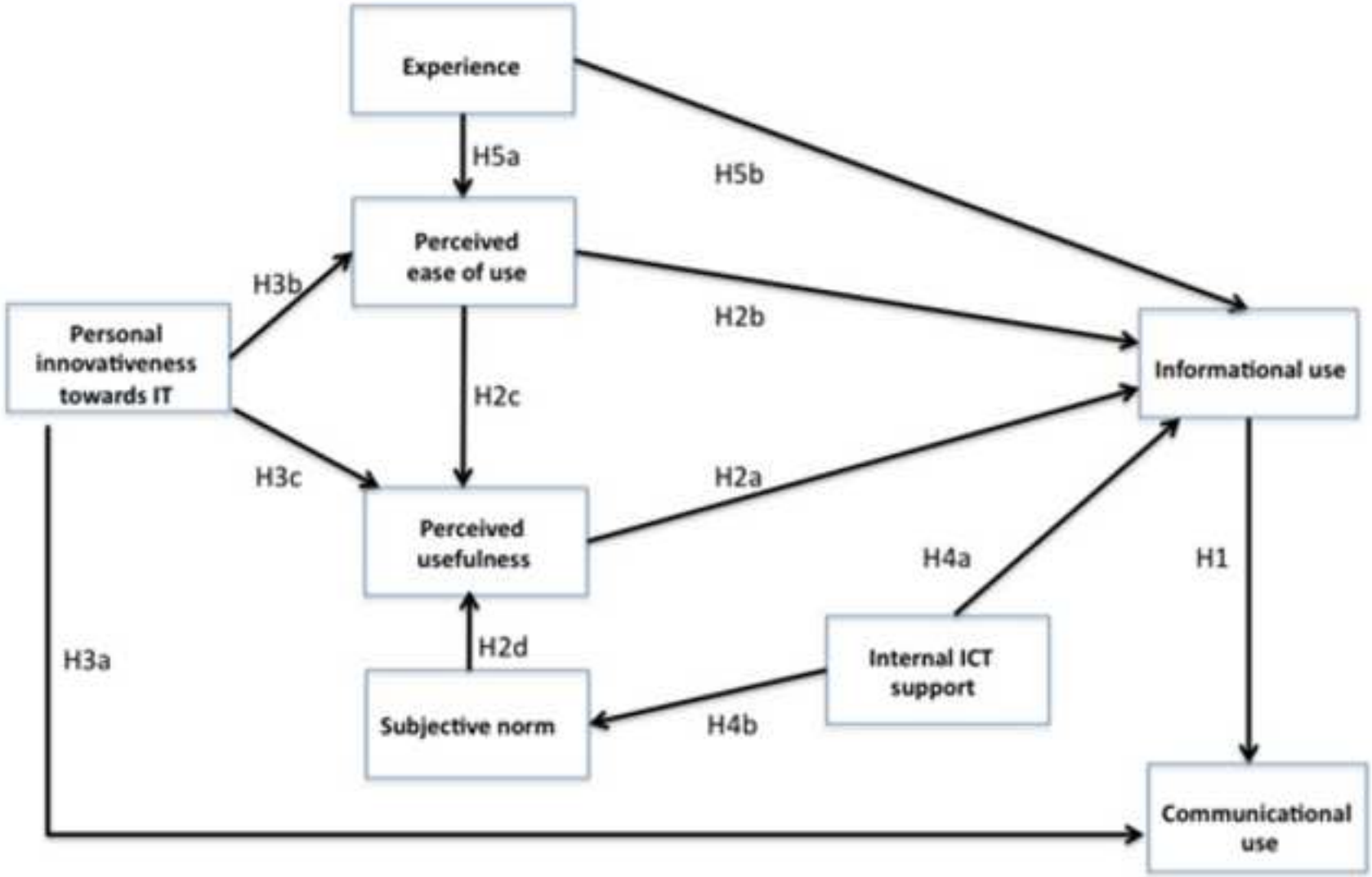

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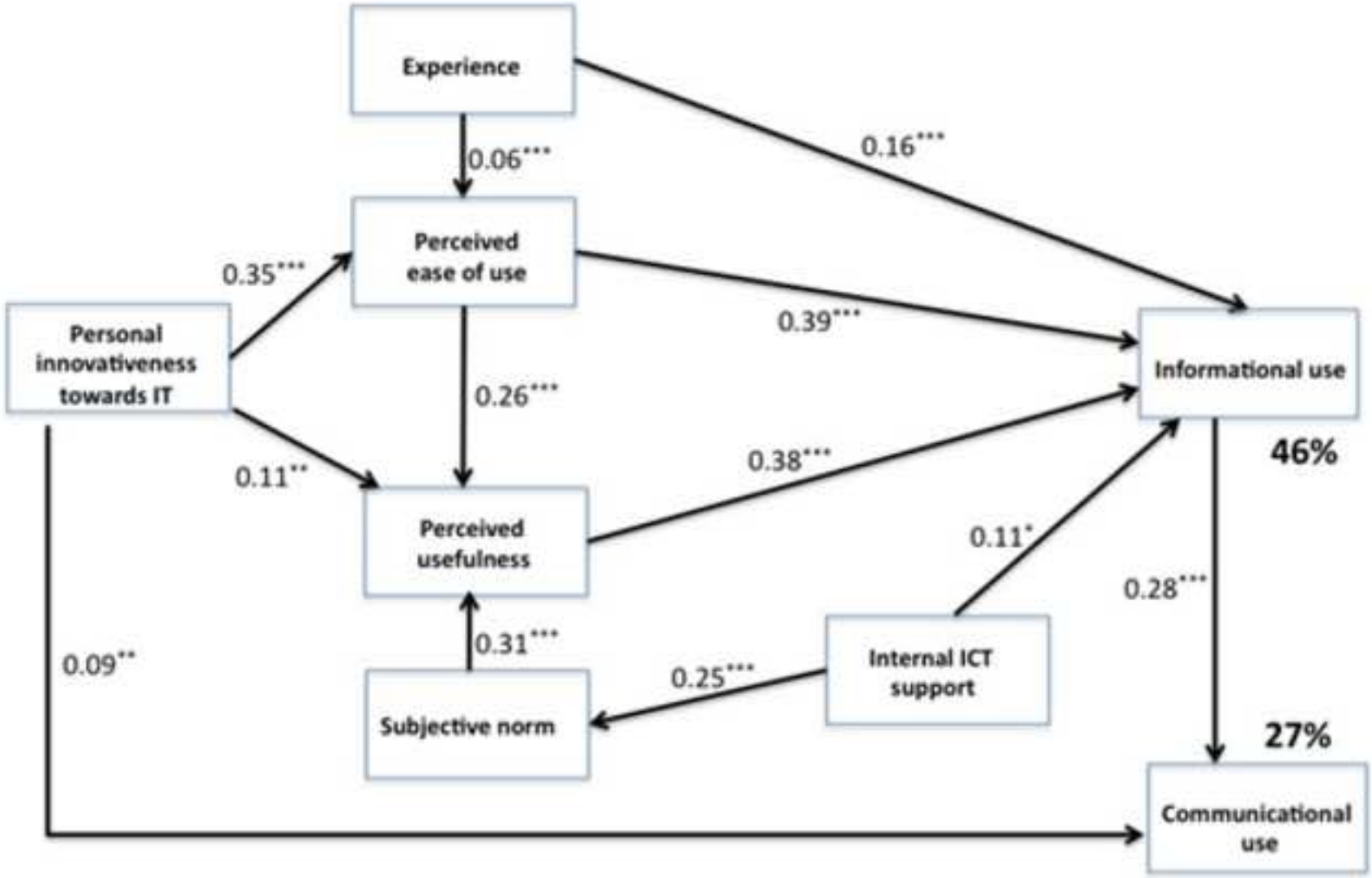
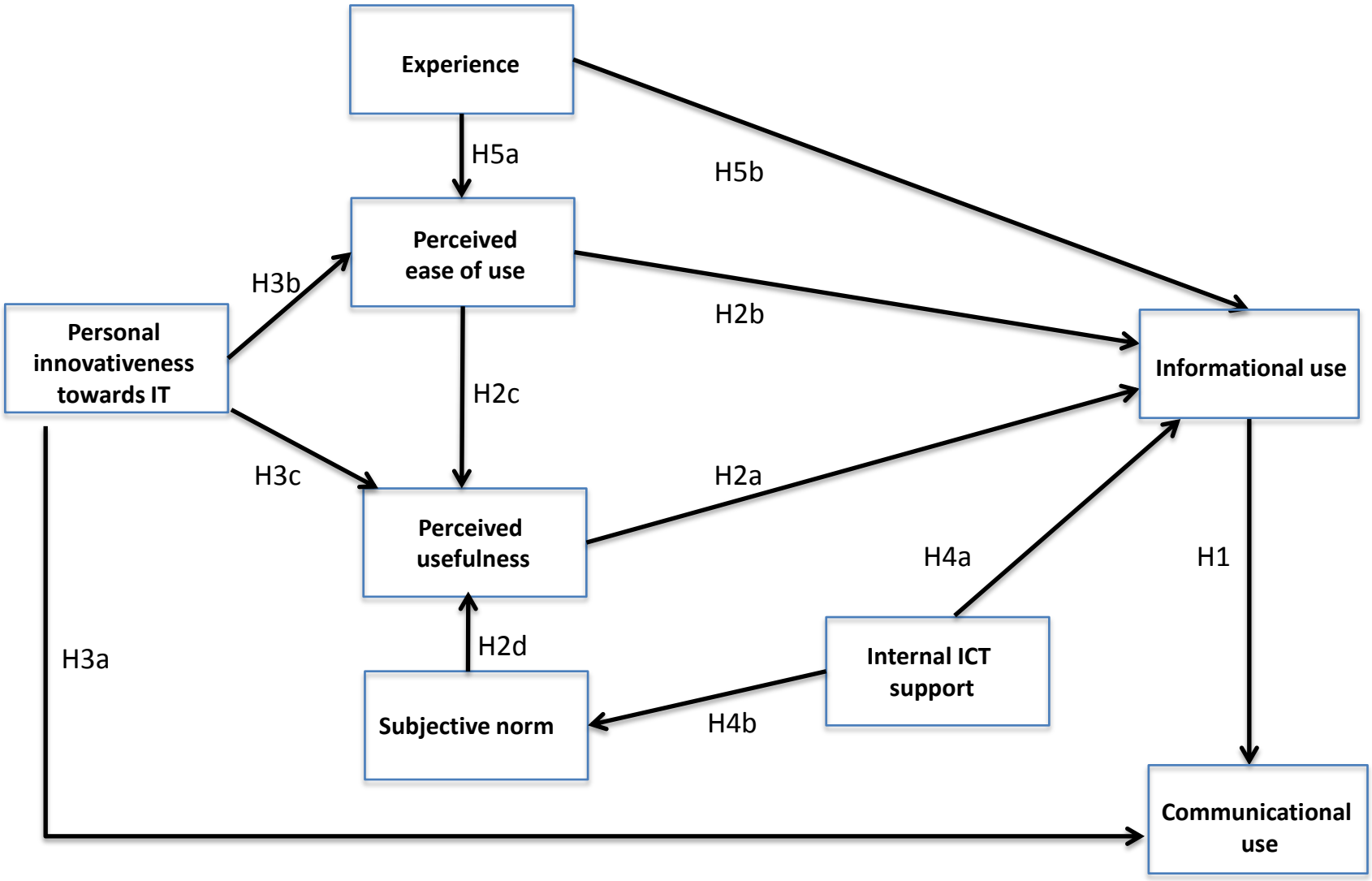
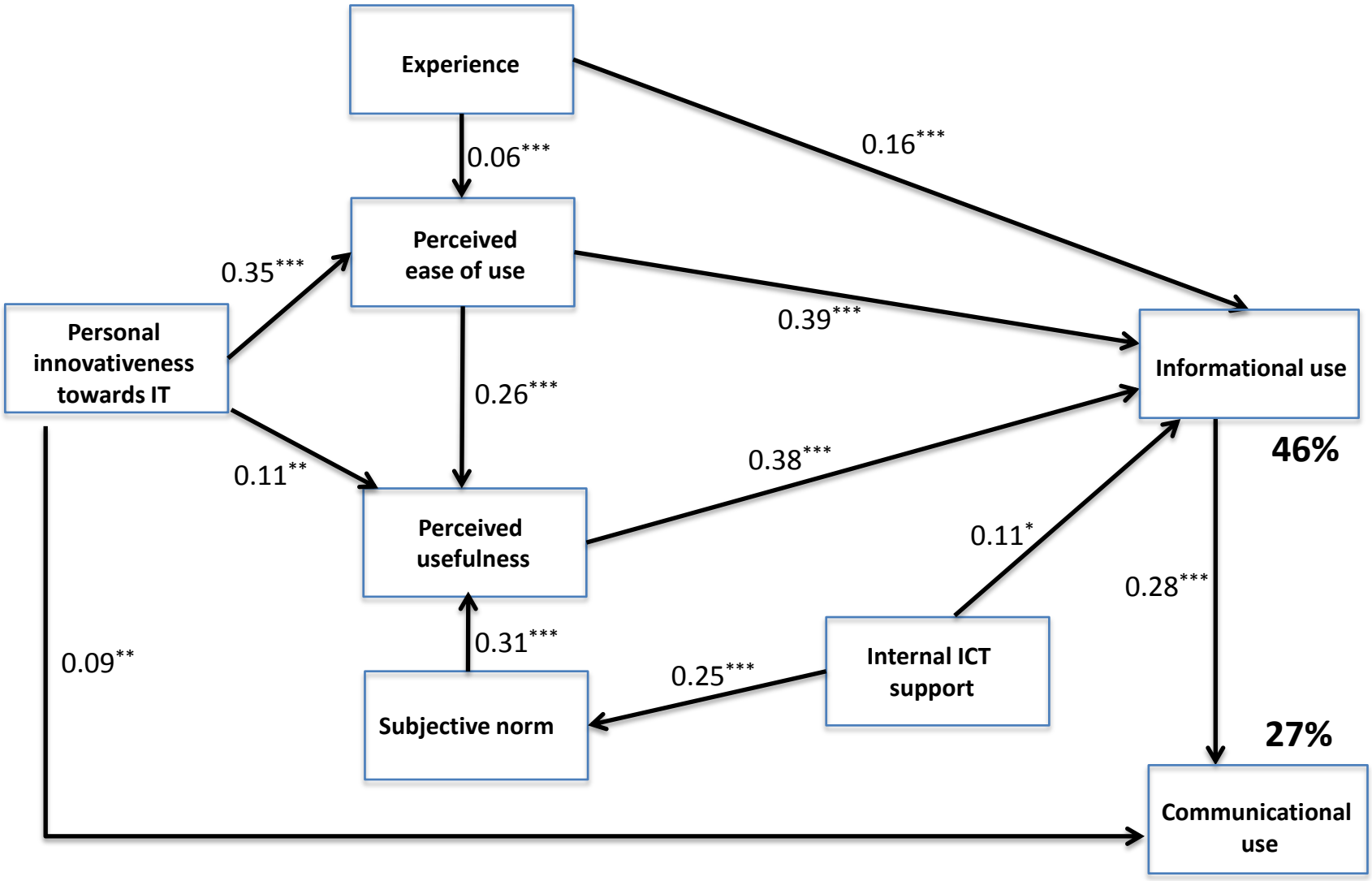


Figure 1 and figure 2 ppt format




Experience
0.06***
0.16***
Perceived ease of use
0.35***
Personal innovativeness towards IT
0.39***
Informational use
46%
0.26***
0.11**
0.38***
Perceived usefulness
0.11*
0.28***
0.31***
0.09**
Internal ICT support
0.25***
Subjective norm
27%
Communicational use

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***Highlights**

This study researches the technology acceptation of LMS by secondary school teachers

Informational use was found to be a precursor for communicational use

Perceived ease of use is the strongest predictor in LMS-acceptation

Internal ICT support has a direct effect on informational use and on subjective norm