Using Elected Elements in Large-Scale Information Systems Lectures

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Abstract. Information systems (IS) lectures often address audiences that consist of over one hundred students. In this setting, it is arguably difficult to consider the individual interests of each participant. This may result in students not being motivated, decreased learning outcomes as well as an overall low effectiveness of IS lectures. Self-determination theory suggests that perceived autonomy increases intrinsic motivation, which may in turn lead to improved learning outcomes. We therefore propose to foster perceived autonomy among students by introducing elected elements (e.g., practical examples and topics) that students can vote for with an audience response system. To investigate this instructional approach and to provide an instrument for its evaluation, we conducted a preliminary study that shows positive associations between perceived autonomy, intrinsic motivation, as well as acceptance among students. Based on these findings, we derive several avenues for future research regarding the use of elected elements in large-scale IS lectures.

Keywords: Information Systems Lectures, IS Curriculum, Self-Determination Theory, Audience Response Systems.

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1 Introduction

Undergraduate enrollment in degree-granting postsecondary institutions has continuously grown over the past decades. For instance, in the year 2013, this enrollment has increased by 46 percent in the United States compared to the year 1990 [1]. This growth results in information systems (IS) lectures that often address audiences consisting of over one hundred students that passively listen to instructors [2]. In this setting, it is arguably difficult to meet the individual interests of each participant for instance in terms of how the knowledge is embedded in practical examples. This may result in students not being motivated, decreased learning outcomes as well as an overall low effectiveness of IS lectures [3, 4]. Self-determination theory suggests that a possible way to foster students' intrinsic motivation is increasing their perceived autonomy [5], i.e. their perception of being able to choose topics and to influence the course of the lectures. However, asking each and every student about how the lectures should unfold is practically impossible in large-scale lectures.

We therefore propose to use pre-fabricated elements (e.g., practical examples, topics, etc.) that students can choose from in every lecture by voting in an audience response system (ARS). The main idea is that every lecture contains both mandatory elements to ensure certain learning outcomes are met as well as elected elements that meet students' interests and provide a feeling of influence on the course. We therefore pose the following overarching question of our research project:

RQ: What are the impacts of providing elected elements in large-scale information systems lectures on students' intrinsic motivation and learning outcomes?

In this paper, we report the results of a preliminary, cross-sectional study conducted in an introductory IS course at a German university, where students were given the choice over several elected elements in each lecture. After the course was finished, different aspects of intrinsic motivation and perceived autonomy were assessed with a brief questionnaire based on the intrinsic motivation inventory [6]. In the present study we were primarily interested in (a) analyzing the psychometric properties of the items and respective scales to provide a reasonable and valid measurement for a subsequent quasi-experimental field study, (b) exploring the acceptance and practicability of the instructional approach by gathering students' qualitative feedback as well as their ratings on an additional "Desirability" scale, and (c) providing first indications regarding its motivational benefits by examining qualitative feedback and performing correlational analyses of students' self-reported perceived autonomy, intrinsic motivation (in terms of interest/enjoyment), and subjective value (in terms of perceived usefulness) of elected elements. Based on the theoretical assumptions of self-determination theory, we expected positive associations between perceived autonomy and intrinsic motivation on the one hand, and intrinsic motivation and perceived value of elected elements. Due to privacy concerns, we were not able to collect performance data (i.e., learning outcomes) in the present study, which will be included in the subsequent study by using anonymous ID-codes.

The remainder of this paper is organized as follows: First, we provide the theoretical background for this study as well as related work. We then report the setup, method, and results of the preliminary study. Afterwards, these results are discussed and avenues for future research are shown in the concluding section.

2 Theoretical Background and Related Work

Self-determination theory stems from motivational psychology and provides several explanations for human motivation [5]. One of its central assumptions is that intrinsic motivation (i.e., the highest level of self-determination; when individuals engage in behavior for the pleasure and satisfaction that they inherently experience with participation [5]) requires the satisfaction of three basic psychological needs: Perceived competence, relatedness, and autonomy [7]. While perceived competence in lectures is already addressed by approaches that test knowledge and understanding of students [8] and relatedness might be covered with peer-reviewing activities [9], perceived autonomy (i.e., being able to influence the course of the lectures) is still rarely addressed by existing studies. While achieving intrinsic motivation among students is one goal of higher education, increased motivation should also lead to better learning outcomes. Indeed, several studies have provided evidence for a link between intrinsic motivation and learning outcomes, such as improved grades [10] or high academic performance through increased study effort and deep learning [11].

By using ARS, which are sometimes also called Audience Response Technology, Personal Response Systems, Electronic Voting Systems or simply "clickers" [12], students may participate in votes with electronic devices. Depending on the infrastructure of the institution (e.g., wireless LAN), this approach may involve many participants [2], which makes it applicable in large-scale lectures (100+ students) as well as in smaller lectures. In addition, studies show that technology-savvy students appreciate ARS, which indicates its usefulness in IS lectures [8]. Several different electronic voting mechanisms have been proposed and used thus far. One popular approach is to distribute designated voting devices to students which they sometimes also have to purchase [8]. However, since the advent of smart phones and tablets, ARS that allow students to use their own devices promise to lower expenses on infrastructure [13]. For this reason, we used such an ARS in the present study. Previous studies that investigated the use of ARS to alleviate the consequences of passive listening in large-scale lectures reported increased engagement [14–17], increased overall satisfaction of students [18–20] as well as increased learning outcomes [14, 21, 22]. However, most of these studies only use ARS to test knowledge of students [16, 17, 22] or to ask for their opinions regarding the content [8]. Only one approach we found in literature might facilitate perceived autonomy by utilizing so-called "clicker cases", where ARS were used by students to choose several actions in a case study [14]. Although this approach shows how ARS can lead to improved participation, the authors did not examine whether these choices actually had an impact on perceived autonomy of students. Since this theoretical lens may increase our understanding of ways to foster students' perceived autonomy and ultimately intrinsic motivation in large-scale IS lectures, we

focused on perceived autonomy and its associations with other motivational constructs that are described in the following. It is important to note, however, that in this preliminary study we solely address these motivational aspects and the practicability of this specific instructional approach. On the basis of the present findings (improved measurements and instructional approach), the effects of elected elements will be examined in a subsequent quasi-experimental field study with "using elected elements" as independent variable and students' motivation and performance as dependent variables.

3 Preliminary Study

3.1 Implementing Elected Elements in IS Lectures

To investigate the associations between providing elected elements in large-scale IS lectures and students' perceived autonomy as well as intrinsic motivation, we implemented such elements in an introductory IS course at a German university. The course consisted of 12 lectures that were given weekly over a period of 6 months. At the end of each lecture, students were able to vote which element they wanted to be addressed in the following lecture out of 2-4 options. To foster student participation, we used an ARS that allowed students to use their mobile devices (e.g., smart phones, tablets) for voting anonymously [13]. Figure 1 provides a visualization of lectures incorporating elected elements.

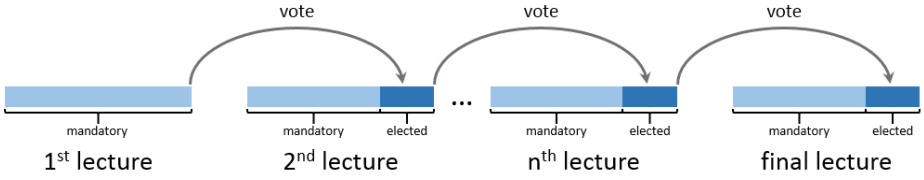

Figure 1. Lectures incorporating elected elements

The elected elements ranged from choosing between different practical examples to choosing between different software demonstrations. For instance, one week before the lecture about business process modeling took place, students were able to choose between activity diagrams and business process model and notation (BPMN) as additional modeling notations. Although these notations are quite similar regarding how they depict business processes, students may get a feeling to be able to choose between a more universal notation (activity diagram) and a notation specifically designed for business processes (BPMN). This way, certain learning outcomes may be enforced while still providing a sense of influence. After voting, students were able to see the distribution of votes between the elected elements. They hence received immediate feedback whether their vote belonged to the majority or not. Due to the fact that every student could participate in many polls, it was very unlikely that they always ended up in the minority, which would arguably reduce their perceived autonomy.

3.2 Method

At the end of the course, after all lectures were finished, we conducted a paper-based questionnaire (see Appendix) in class. Hence, we followed a cross-sectional design in this preliminary study. Data collection was conducted by the first author. Out of the 64 questionnaires we received, 58 have been valid (i.e., 6 were discarded because of obvious dishonesty like wrong fields of study or because they could not participate in the polls due to technical errors with their mobile devices). Since the average number of participants in the votes is 57, the dropout rate appears to be low. Participants consisted of 44 males and 14 females, enrolled in two different fields of study (45 participants studied business and information systems engineering and 13 studied computer science). The age was 20.2 years on average (*SD*=2.7).

The questionnaire adapted items from the intrinsic motivation inventory (IMI) that has been used in many studies to measure perceived autonomy as well as intrinsic motivation of participants [6, 23, 24]. For our preliminary study, we chose three items from each of the following subscales: "Interest/Enjoyment" (e.g., "I would describe the elected elements as very interesting") was used to assess intrinsic motivation, "Perceived Choice" (e.g., "I voted for elected elements because I wanted to") was selected to measure perceived autonomy, and "Value/Usefulness" (e.g., "I think the possibility to vote for elected elements is important") was used to gather an overall rating of subjective value of providing elected elements. Judging an activity to have personal value and importance can be seen as (antecedent) part of intrinsic motivation [5], and therefore it should be positively related to interest and enjoyment. All items were modified to relate to the context and translated into German. However, since these adapted items did not fully cover our research question, we added two self-developed subscales, each comprising three items. "Perceived Influence" (e.g., "By voting for elected elements I felt that I could influence the lectures") addressed an additional aspect of perceived autonomy, since the "Perceived Choice" subscale exclusively asked whether students believed that they participated voluntarily in the polls. However, we also wanted to know whether they believed that their votes had an impact on the lectures. Finally, "Desirability" (e.g., "I wish I had the possibility to vote for elected elements in other courses, too") was added as another way of asking for an overall rating of providing elected elements, since the "Value/Usefulness" subscale only asked whether elected elements are important to students. While this is a possible approach to determine an overall rating, we also wanted to know whether students thought that providing elected elements makes sense and whether they wish having these elements in other courses, too. Every subscale except for "Value/Usefulness" contained one reversely coded item that was used to identify fraudulent questionnaires (i.e., there should be no contradictions). Each item in the questionnaire was assessed using a 5-point scale, ranging from 1 = *not at all true* to 5 = *very true*, and they were randomized across all subscales. In addition to the quantitative items, students were provided with space for leaving any comments or suggestions on the possibility of voting for elected elements. All subscales as well as their respective internal consistencies (Cronbach's α) are presented in Table 1. Reliabilities were satisfactory for all subscales, except

"Perceived Choice". Thus, the subscale "Perceived Influence" provided a more consistent measurement of perceived autonomy, and "Perceived Choice" was omitted.

Table 1. Subscales and Cronbach's α

Subscale	Number of Items	Cronbach's α
Interest/Enjoyment	3	0.79
Perceived Choice	3	0.43
Perceived Influence	3	0.82
Value/Usefulness	3	0.83
Desirability	3	0.83

3.3 Results

Confirmatory factor analysis, used to verify the latent factor structure (i.e., subscales) of the measurement instrument, revealed an acceptable fit for the remaining four subscales (χ^2=68.19, *df*=48, *p*=0.03, CFI=0.95, TLI=0.92, RMSEA=0.08). Standardized item loadings were in the range of λ = 0.67 - 0.85, thus satisfactory. The usual and recommended cut-off scores for RMSEA are ≤ 0.05 for a good fit and ≤ 0.08 for an acceptable fit. CFI and TLI should be ≤ 0.95 for a good fit, and ≤ 0.90 for an acceptable fit [25]. Hence, all further analyses were based on the four subscales "Interest/Enjoyment", "Perceived Influence", "Value/Usefulness", and "Desirability". The descriptive statistics are shown in Table 2. The item numbers indicate the sequence of questions. Bivariate intercorrelations (manifest) also indicate discriminant validity of the different aspects of motivation (see Table 3).

Table 2. Descriptive statistics of the results (N=58)

Subscale	Item No.	Mean	SD	Power	Loading
Interest/Enjoyment	3	3.76	0.84	0.70	0.78
	12	4.03	0.83	0.63	0.79
	15	3.59	0.74	0.57	0.67
	Total	**3.79**	**0.67**		
Perceived Influence	4	3.60	0.95	0.64	0.70
	7	3.45	0.95	0.69	0.84
	8	3.86	0.95	0.68	0.76
	Total	**3.64**	**0.81**		
Value/Usefulness	9	3.53	0.99	0.60	0.69
	14	3.36	0.96	0.73	0.83
	10	3.40	1.08	0.73	0.85
	Total	**3.43**	**0.87**		
Desirability	5	4.12	0.97	0.72	0.79
	16	3.98	0.88	0.60	0.77
	11	4.40	0.83	0.75	0.81
	Total	**4.17**	**0.77**		

A closer look at the distributions of these subscales is provided in Figure 2.

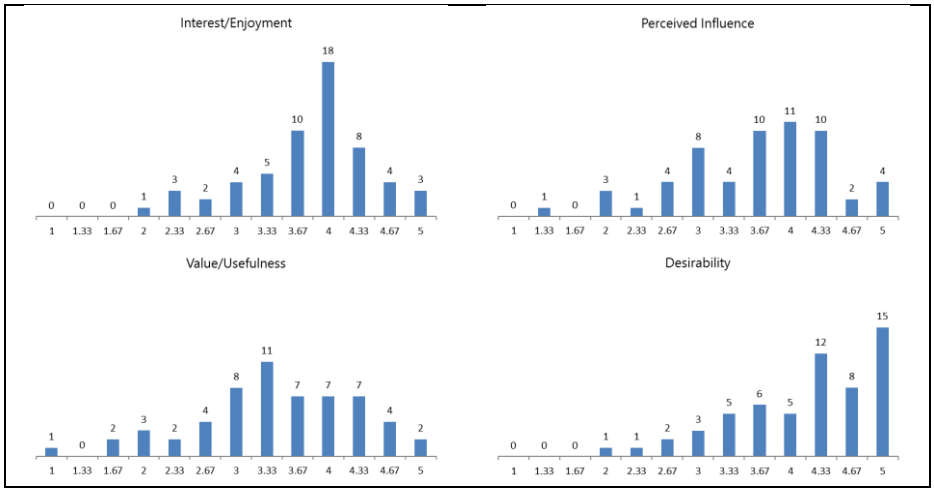

Figure 2. Distribution of each subscale

As Figure 2 shows, particularly the distribution of "Desirability" was more concentrated towards the higher end of the scale (negative skew) whereas the distribution of "Perceived Influence" was rather scattered. Students generally reported rather high levels of interest and enjoyment after using elected elements and they reported a strong desire to have such elements in other courses. Students' ratings regarding the value and importance of these elements as well as the amount of perceived autonomy in terms of perceived influence they had on the course differed.

Students' qualitative feedback supports these assumptions by comprising both positive as well as negative comments on the implemented instructional approach. Many students appreciated being able to vote for elected elements in each lecture. Some of the comments also directly state that the interest in the lecture increased by choosing elected elements (45% of all comments):

"By being able to vote for elected elements, one is able to influence the content of the lectures -> increased interest."

"The interest in the course increases when elected topics are covered."

"I really liked deciding for the topics that I was most interested in."

However, there was also criticism regarding how the elected elements were covered in the lectures. The main concern was that they have been too short compared to the mandatory parts of the lectures (36% of all comments):

"The idea of providing elected elements is very good. However, they often have been addressed shortly at the end of the lectures. For example, we were shown how a system from SAP looks, however, I seldom understood how it worked."

"I like being able to vote for elected elements as well as the use of them – However, they have been covered too short in the lectures. When using elected elements, you should take enough time for them."

"Despite the elected elements often being very interesting, they have been covered way too short in the lectures, which made the choices feel pretty pointless."

Additional criticism addressed both the amount of information that was provided before voting for elected elements as well as the unclear relevance of these elements in the examination (18% of all comments):

"More info about the elected elements would have sometimes been useful for better forming an opinion."

"The relevance of the elected elements for the examination has sometimes been unclear (they don't appear in the script and there is no handout)."

In summary, the qualitative feedback emphasized that providing elected elements in IS lectures may lead to increased interest and motivation. It also shows, however, that these elected elements should have more room inside the lecture. Otherwise, they could be perceived as pointless which may reduce perceived autonomy. Finally, students have to be supplied with enough information about each alternative to be able to make a well-informed decision.

Regarding the associations between perceived autonomy and intrinsic motivation due to elected elements in IS lectures, we found a significant positive correlation between students' interest/enjoyment and perceived influence (see Table 3). In addition, we found a positive correlation between interest/enjoyment and perceived value in terms of the rated usefulness of elected elements and the desire to use ARS in other lectures as well. Finally, the latter was positively correlated with perceived influence.

Table 3. Bivariate correlations (**p < 0.01)

	Interest/ Enjoyment	Perceived Influence	Value/ Usefulness	Desirability
Interest/Enjoyment	1			
Perceived Influence	0.55**	1		
Value/Usefulness	0.58**	0.49**	1	
Desirability	0.78**	0.60**	0.62**	1

These positive correlations support our initial expectations concerning the associations between perceived autonomy and intrinsic motivation due to elected elements. We hence propose that fostering perceived autonomy by using elected elements in large-scale IS lectures may have the potential to increase students' motivation in terms of subjective value, interest and enjoyment. These correlational findings provide a basis for future research, more specifically for the intended quasi-experimental study with a comparable student population, to examine causal effects of this instructional approach on students' motivation and achievement.

4 Discussion

The results of this preliminary study indicate that providing elected elements in IS lectures might lead to perceived autonomy and increased intrinsic motivation among students. Our findings, based on qualitative and quantitative data, provide a first step towards understanding the effects of using elected elements in large-scale IS lectures. In addition, these elements are perceived well by the participants. The short-scale measures used in this study proved to be reliable to assess "Interest/Enjoyment", "Value/Usefulness", "Perceived Influence", and "Desirability". Since most students enrolled in IS programs are equipped with mobile devices, they provide a good opportunity to let students vote for their favorite content. Once these elected elements are created by the instructor, they may be used several times and even in several different courses. Because many ARS have been improved over the years, conducting these polls is uncomplicated and arguably fewer effort than for example setting up blended learning scenarios with extensive online content. The present study extends prior research by adding a self-determination theory perspective to explain increased motivation when using ARS by increased perceived autonomy during the lectures.

There are, however, some limitations to this study. First, due to the selected ARS, individual choices of students have not been tracked. We were hence unable to investigate motivational differences between students who often voted like the majority compared to those who did not. This might have been one reason for students' differences in perceived influence. Some students also reported technical problems either with their devices or with the network inside the lecture room. To ensure scalability, an ARS that is able to handle many connections at the same time should be used. According to the comments of students, elected elements should have more room inside each lecture. Indeed, these elements sometimes just comprised 10 minutes inside a 90-minute lecture. We will hence prolong them in future investigations. Another limitation of the study is the lack of a control group. We therefore cannot compare the achieved level of intrinsic motivation from using elected elements with a group that did not use these elements. In addition, performance data of students could not be mapped to the questionnaires due to privacy concerns. Hence, we could not investigate whether those students who reported higher levels of perceived autonomy and intrinsic motivation actually performed better than their peers with lower levels, respectively. In a next step, we will include these aspects in the subsequent study design following a quasi-experimental design.

5 Conclusion

In regard to the findings above, instructors from the IS domain may consider incorporating elected elements into their lectures. When doing so, these elements should noticeably influence the contents of the lectures and students must be supplied with sufficient information about every alternative before voting. Due to the limitations mentioned earlier, this study is only a first step towards understanding the use of elected elements in IS lectures. In the subsequent study, we will track individual choices of each participant to see whether students who have often voted like the majority are more motivated than others. Additionally, performance data of each student will be tracked to investigate effects on student learning. This may include results from examinations as well as other performance indicators, such as regularly performed quizzes. Since offering lectures is often a necessity due to increasing enrollment, our preliminary results highlight one feasible opportunity to improve this experience for both students as well as instructors.

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Appendix

Questionnaire. Reversely coded items are marked with (R)

Subscale	No.	Item
Interest/Enjoyment	3	The elected elements have been fun.
Interest/Enjoyment	12	I thought the elected elements have been boring. (R)
Interest/Enjoyment	15	I would describe the elected elements as very interesting.
Perceived Choice	13	I voted for elected elements because I wanted to.
Perceived Choice	6	I felt like I had to vote for elected elements. (R)
Perceived Choice	2	I believe I could choose whether to vote for elected elements or not.
Value/Usefulness	9	I think the possibility to vote for elected elements is important.
Value/Usefulness	14	I believe the possibility to vote for elected elements could be beneficial to me.
Value/Usefulness	10	I believe the possibility to vote for elected elements could be of some value to me.
Perceived Influence	4	By voting for elected elements I felt that I could influence the lectures.
Perceived Influence	7	By voting for elected elements I had the impression of being able to codetermine the contents that have been taught.
Perceived Influence	8	I believe that by voting for elected elements I was unable to influence the lectures. (R)
Desirability	5	I think that the possibility to vote for elected elements makes sense.
Desirability	16	I wish I had the possibility to vote for elected elements in other courses, too.
Desirability	11	The possibility to vote for elected elements should be dropped from the course. (R)
Comment (open ended question)	-	I want to note the following regarding the possibility to vote for elected elements at the end of each lecture.