Incorporating Students’ Self-Efficacy and Subject Value in the Evaluation of Audience Response Systems

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Abstract
An audience response system (ARS) enables students to answer questions presented in class and thereby, it promotes active learning. For this reason, ARSs gained instructors’ attention and a considerable amount of literature has been published on the benefits of ARSs. However, prior studies lack a suitable methodology. The current paper seeks to remedy this problem and develops a conceptual framework which proposes that besides the user-friendliness of an ARS, students self-efficacy, and subject value are key underlying forces that explain the perceived effects and benefits of ARS in enhancing students’ learning performance and attitude towards using the system. The empirical test of the proposed framework attests to the importance of self-efficacy and subject value in the context of ARS and confirms the impact on learning, engagement, and enjoyment which in turn, promotes ARS usage and/or learning enhancement.

1. Introduction
Student enrolment numbers at universities have increased dramatically [1]. In Austria, for instance, enrolments at public universities have gone up by around 50% from winter term 2001/02 to winter term 2012/13 [2]. Since government funding allocation has failed to match the escalating personnel requirements, the student-faculty ratio is nowadays problematic at many universities [3]. Hence, rather large class-sizes are quite common, especially in undergraduate education. These large class-sizes combined with auditorium-style seating and a lecture teaching-style leads to a learning environment that is experienced as impersonal [4] and disengaging [5]. Research has further shown that students’ attention already starts to slacken after 10 to 15 minutes passively listening to a lecture [6]. Thus, active learning techniques such as discussing, solving problems, or answering questions that involve students in an activity would be superior [7]. By using these active learning techniques, students think about the material [7] which leads to higher performance in examinations compared to traditional lecturing [8, 9]. Not surprising is that the unfavourable student-faculty ratio expressed in large class-sizes makes it extremely challenging for instructors to engage all students in class [10]. In addition, in such an environment instructors have difficulties in monitoring students’ understanding and modify their instruction in case of misconceptions in real-time [10].

A technology solving these problems would be an audience response system (ARS) which is referred to by numerous names in the literature including audience polling system [11], classroom feedback system [12], electronic [13] or interactive voting system [14], classroom [11], electronic [15], group [16], personal [17], or student response system [18, 19], personal response station [20], and the more colloquial term “clicker” [11, 18, 21].

The ARS is known from TV shows such as “Who Wants to Be a Millionaire?” when the candidate becomes puzzled by a question and asks the studio audience which answer they believe is correct. Then, each member of the studio audience indicates his/her choice by pressing a button on a handheld device and the candidate will receive the result of the vote immediately in an aggregated form. For the studio and TV audience the distribution of the answers is presented on a monitor in the form of a bar chart. From this description we can directly see how an ARS can be applied in a classroom setting and that it offers an approach to employing active learning in the classroom. Literature reviews by Kay & LeSage [22] examining 52 peer reviewed articles and by Penuel et al. [23] inspecting 49 studies support the effectiveness of ARSs by reporting higher participation, engagement, attention, and quality of instruction as well as interaction but highlights the importance of meaningful questions or question where students have to apply their knowledge. Furthermore, Kay & LeSage [22] found that ARSs are applied for tests and to provide feedback on students’ performance and understanding which is valuable for both instructors and students.

However, Kay & LeSage [22] also identified
Given these challenges, the paper aims to better understand students’ perception of ARS benefits and their attitude towards ARS usage at which students’ belief in their own ability and the relevance or value of the course for them may play a major role. For this reason a research model is developed comprising several issues known to be important in information systems and educational research. In particular, special attention is also given to the examination of the validity and reliability of the measurement instruments to overcome previous shortcomings.

2. Theoretical background

2.1. Description of audience response systems

ARSs are the technological realization of flash cards in different colors which are used by the audience to respond to an instructor’s question simultaneously. The first ARSs were already introduced in the 1960s but this first generation of ARSs was expensive and usage was complicated [24]. Therefore, widespread use did not emerge until 2003 when the second generation of ARSs became wireless [25] and more affordable [24]. These ARSs of the second generation are still in use [25] and require a specific hardware infrastructure (i.e., a receiver unit), a technical infrastructure such as handheld devices (i.e., clickers) or integrated transmitters into the students’ desks, and software used for compiling questions as well as for recording, aggregating, and displaying the response data [17, 26]. ARSs are either built on infra-red or radio-frequency technology [17]. While infra-red technology is cheaper, radio-frequency technology can handle more participants per receiver, is less sensitive to the positioning of the receiver, and the signal has a greater range [11] (about 300 m compared to 25 m for the infra-red handheld device) [17]. That is why infra-red technology is becoming outdated [11]. However, in Austria, for example, various radio-transmitting products violate the Austrian law of radio-frequency usage [26] and that is why application is not possible. Drawbacks regarding the usage of this second generation are also stressed by instructors. Besides the time-consuming set up of equipment, instructors claim that technical assistance is necessary at an application’s start-up [27]. Further constraints are seen in the effort and time spent on borrowing and returning the handheld devices (and mobile receiver units) [27] and for student-owned handheld devices, it is observed that 25 - 35% of students fail to bring their devices to class [13].

Thus, a third generation of ARSs was introduced and is now used as an alternative. These are based on the web, on short-message-service (SMS), or on a combination of both [26]. Such systems are promising because in Europe there are 125 mobile-cellular subscriptions per 100 inhabitants and 64 out of 100 inhabitants have an active mobile-broadband subscription [28]. For young people figures differ. In Austria, for instance, already 89% of the inhabitants between 16 and 24 years of age have a mobile device to go online [29] and it is perceived that this number is even higher for students. In the web-based solution of ARS, instructors use a web interface to raise questions which are answered by the students either via a web interface, Twitter, email, or a combination of the three [26]. Drawbacks of existing web-based ARSs include cost and privacy issues. Usage of some ARSs is only free of charge for small classes (40 audience members) and for larger classes costs are high or difficult to estimate [26]. Further, user data need to be sent to external providers which implies on the one hand dependency on the availability of the service of the respective provider and on the other hand, concerns regarding data security [26]. For the SMS-based solution instructors still need a special software to handle the posts and responses while students can use their mobile phones to answer the questions via an SMS [30]. Shortcomings of SMS-based ARSs identified are the costs of sending SMS that hindered students to participate [30] and the time needed to type an SMS which may draw off the attention from what is being presented by the instructor [31]. Hence, a combination of both, a browser-based mobile ARS overcomes the deficiencies of the other solutions and is recommended by Andergassen et al. [26]. Then, neither additional software nor special technical equipment is needed, and since most universities provide WLAN for free to their students costs for participating are eliminated.

2.2. Framework development and hypothesized model

Self-efficacy is a student’s belief in their own ability to master a challenge or reach a goal [32, 33]. Self-efficacious students participate more readily and work longer and with more effort than students with doubts in their capabilities [33]. They show more interest in carrying learning tasks [32, 34] and active
learning strategies [35] which suggests that the introduction of an ARS is seen as useful by self-efficacious students since they get valuable feedback on their learning. For this reason self-efficacious students will have a positive attitude towards using an ARS. However, students will not benefit from engagement since these students participate in class anyhow and do not need a motivation to do so. Literature further suggests that self-efficacy enhances performance [33, 36]. Since students with a high magnitude of self-efficacy already believe in their ability to master the course [32, 33] it is assumed that the application of ARS does not have an influence on their perceived learning enhancement. Further, it is found that students ascribe a greater utility value to activities or subjects in which they feel competent (i.e., in which they have a higher level of self-efficacy) [37]. In relation to the above literature, the following hypotheses are concluded:

**H1:** Self-efficacy has a direct positive effect on learning benefit caused by ARS.

**H2:** Self-efficacy has a direct positive effect on attitude towards using ARS.

**H3:** Self-efficacy has a direct positive effect on subject value.

Subject value refers to peoples’ perception of the relevance of a course or subject matter for individual career goals [32]. In Eccles’ expectancy-value theory this description is termed utility value [37]. In case, tasks are of high subjective interest they will be done because of the intrinsic motivation of individuals [37]. Hence, in the study of Tulisa & Ainleyb students who report interest also testify enjoyment [38]. Moreover, it has been demonstrated that a highly valued subject triggers engagement in class activities and leads to the employment of more effective learning strategies [32, 39]. Thus, interested students will perceive an ARS beneficial, engaging, and with enjoyment which further implies a positive attitude towards using ARS. Again, no importance is attached to the proven relationship between subject value and success [37] because the need of an additional motivation due to the application of an ARS will probably be neglected by interested students. As a result, the hypotheses derived are:

**H4:** Subject value has a direct positive effect on engagement benefit caused by ARS.

**H5:** Subject value has a direct positive effect on learning benefit caused by ARS.

**H6:** Subject value has a direct positive effect on perceived enjoyment caused by ARS.

**H7:** Subject value has a direct positive effect on attitude towards using ARS.

Perceived ease of use can be defined as an individual’s opinion that the application of a system will be free of effort [40]. In case a system is user-friendly, it is more fun to use [41] which also holds true for the usage of ARS [42]. In addition, such user-friendly systems are considered to be more beneficial and useful [43]. Since other studies have identified perceived ease of use as a strong predictor of attitude towards using systems such as electronic mailing systems and text editors [44] or e-learning systems [45], it is expected that this relationship can be transferred to ARS. Considering the above arguments it is proposed:

**H8:** Perceived ease of use of the ARS has a direct positive effect on engagement benefit caused by ARS.

**H9:** Perceived ease of use of the ARS has a direct positive effect on learning benefit caused by ARS.

**H10:** Perceived ease of use of the ARS has a direct positive effect on perceived enjoyment caused by ARS.

**H11:** Perceived ease of use of the ARS has a direct positive effect on attitude towards using ARS.

Perceived enjoyment is conceived as the pleasure one gains from an activity such as the usage of a system [46]. It is an intrinsic value [37] or intrinsic motivation [47] which plays a major role in the learning context [48] because it has a direct impact on a student’s learning success [49]. That is why applying ARS should be fun and several scholars [e.g., 11, 50] confirm that in classes with ARS usage students’ enjoyment is higher than in classes without ARS usage. Previous research suggests that for intrinsically motivated people, due to perceived enjoyment, acceptance [51] and usage of a system will be significant higher [52]. Therefore, ARS is experienced as a positive addition to class and a fun factor [18]. For these reasons the following hypotheses are posed:

**H12:** Perceived enjoyment caused by ARS has a direct positive effect on learning enhancement.

**H13:** Perceived enjoyment caused by ARS has a direct positive effect on attitude towards using ARS.

Engagement is shown by persons who “employ and express themselves physically, cognitively, and emotionally during role performances” [53, p. 694] and thus, it is identified to be a predictor of students’ performance [21]. Engagement can be fostered by a teaching-style of questioning because it encourages students to get prepared for class in order to be able to give the correct answers to the questions [5]. This means that it enhances active participation as well as
engagement, and as a consequence it results in better grades [5]. ARS is also working with the teaching-style of questioning, and so, an ARS promotes engagement [22, 23] and thereby, individual outcomes [16]. Hence, it is assumed that students who are encouraged to participate actively due to the usage of ARS will perceive an enhancement of their learning outcome. In addition, students who benefit from engagement will as well show a positive attitude towards using ARS. This leads to the following hypotheses:

H14: Benefits from engagement caused by ARS have a direct positive effect on students’ perceived learning enhancement.

H15: Benefits from engagement caused by ARS have a direct positive effect on attitude towards using ARS.

Learning benefits of ARS are reported in several studies [e.g., 19, 54, 55] which are also pointed out by Kay & LeSage [22] and Penuel et al. [23] in their literature reviews. Besides others, the usage of ARS questions holds the advantage to prove the understanding of concepts, correct misconceptions [11, 22], or provide feedback during learning activity [11, 18, 22]. In doing so, ARSs are perceived as useful which can be defined as the degree an individual believes that using the system will enhance his or her performance [40, 43] and this implies a positive attitude towards usage. Moreover, it denotes that class time is more efficiently utilized which leads to improved educational outcomes [56]. In conclusion, the following hypotheses can be drawn:

H16: Learning benefits caused by ARS have a direct positive effect on learning enhancement.

H17: Learning benefits caused by ARS have a direct positive effect on attitude towards using ARS.

To sum up this chapter, all hypotheses are visualized in Figure 1, the suggested research model.

3. Study description

3.1. ARS overview

This study uses the browser-based mobile ARS that is developed by the university and according to Andergassen et al. [26] it is built on the OpenACS component of the XoWiki Content Flow [57] package. One advantage of this “home-made” ARS is the integration into the university’s learning management system which means that instructors and students can use a system which they are already familiar with. The ARS allows an instructor compiling multiple choice questions with up to five answer alternatives within the learning management system. For answering the questions no special handheld devices are necessary. Students only need a mobile device (e.g., smartphone, tablet, or laptop) which allows posing ad-hoc questions in the lecture hall. Since WLAN access is provided at the whole campus for the members of the university there are no concerns regarding costs for the access to the ARS. In addition, neither the university nor the students have extra costs for the purchase of ARS devices. As soon as a question is published students are notified by displaying the number of pending questions in a red tinted button in the banner of every page (see Figure 2 – left). By clicking on this button, the pending question is directly shown. Now, the students can select the correct answer and terminate it by clicking “Send” (see Figure 2 – right). Once the instructor has unpublished the question, s/he can view the anonymous results in form of a pie chart and present it to the whole class (see Figure 3). In addition, s/he has the possibility to examine personalized results which track every student’s answer (“Submission list” in Figure 3), this can be used to monitor and grade students’ knowledge and understanding.

Figure 1. Research model

Figure 2. Mobile device presenting a pending question (left) and ARS interface (right)
3.2. Context of the study

The context for this study were two marketing courses at an economics and business university located in Europe in summer term 2014 taught by the same instructor. The first one was held in February/March 2014 and the second one in April/May 2014. In total, 350 students were registered on the courses; however, course attendance was voluntary for the students. The marketing course at the university is designed in a blended learning format which means that the lecture is enhanced by many resources provided on the university’s learning management system (e.g., exercises, mock-exams, or the weekly article). Regarding the lecture, both courses were taught in a fixed seat auditorium-style class-room. They started at 8:00 a.m. on Wednesday for three hours. The course introduced students to the principles and concepts of marketing and provided in-depth exposure to practical examples and applications of managerial decisions. In doing so, a lecture teaching-style enriched with multi-media applications such as videos or current ads is combined with active elements, questioning and the usage of the ARS. In each session four to five ARS questions were posed. During the first session students had the chance to get familiar with the ARS. In the further sessions, students got credits for correct answers to the ARS questions which had the character of bonus points; an enhancement of 2.5% of students’ total points achieved at the final exam was possible. Questions were compiled by the course instructor (and author of the study) who has more than twelve years of experience in the creation of reliable multiple-choice questions and tests. The goal of the ARS questions was that the students thereby recognize the connection between the various concepts of marketing and the application of knowledge. Thus, students saw, for instance, a current ad and had to connect that to the correct strategy for business growth according to the Ansoff matrix.

After the course and before the exam, all registered students were invited to participate in the study and complete an online questionnaire.

3.3. Measurement instruments

The online questionnaire included several constructs arising from the hypotheses. The selection of the items of each construct was based on a carefully performed literature review. Items of subject value and self-efficacy are borrowed and adapted from Pintrich [58], perceived ease of use from Davis [40], perceived enjoyment from Igbria et al. [59], attitude towards using a system from Nysveen et al. [60], and perceived learning enhancement from Sprague & Dahl [61]. Items of learning and engagement benefits are selected from studies of Trees & Jackson [19], Draper & Brown [54], and Draper et al. [55]. In addition, the questionnaire contained general items about students’ demographics. A pretest brought clarity regarding the comprehensibility and clearness of the formulations and scrutinized the measurement instrument.

3.4. Analysis

Since a single data collection method was used to gather the dependent and independent data from the same participants at one point of time, the common method bias (CMB) may pose a problem [62]. Besides several ex ante approaches to reduce the occurrence of the CMB (e.g., randomization of question order, assurance of anonymity), the data was also post hoc evaluated applying the widely-used Harman’s single-factor test [62]. For this test, an exploratory factor analysis using all items in the study is performed to see whether only one single factor appears or whether one general factor accounts for a substantial portion of the variance in the data; in case not, it can be concluded that the CMB is not a serious issue.

A covariance based structural equation modelling (CBSEM) approach is applied, using the software package ‘lavaan’ [63] in R. It starts with the calculation of the measurement model to assess reliability as well as convergent and discriminant validity [64]. This is followed by the evaluation of the structural equation model. Although there is no golden rule in the choice of model fit indices there is an agreement to report several indices because they reflect

![Figure 3. Display of student responses in the university's learning management system](image-url)
different aspects of model fit [65]. As absolute fit indices the Chi–square, the root mean squared error of approximation (RMSEA), and the standardized root mean square residual (SRMR) are used while the Tucker-Lewis index (TLI) and the comparative fit index (CFI) serve as incremental fit indices.

4. Results

4.1. Sample description

The sample of the study consists of 172 students, 77 visited the lecture in February/March 2014 and 95 in April/May 2014 and all of these participants answered ARS questions during the lecture. Students are between 18 and 43 years old, with a mean of 21.91 years (SD=3.26). The mother-tongue of 82.56% of the respondents is German; the remaining 17.44% are mainly from other European countries. A χ² goodness-of-fit test proves that this distributions is in accordance with the population (81.75% student from German speaking countries χ²=.004, p=.947; 18.25% international students with another mother-tongue χ²=.020, p=.887). Among the respondents 50.58% are female and 49.42% are male. The gender distribution again matches that of the undergraduate students at the university (χ² goodness-of-fit test for female students: χ²=.026, p=.873; for male students: χ²<.001, p=.992). Hence, the sample indicates to be representative.

4.2. Measurement validation

Firstly, the data were checked for a possible common method bias applying the Harman’s single-factor test [62]. Its results give evidence that no common method bias exists since not only a single factor was extracted and the majority of the variance was not explained by the first factor.

Secondly, following Anderson & Gerbing [66], the constructs were examined for reliability and validity before testing the CBSEM. All item loadings of the constructs are higher than .710. For this reason, individual-item reliability is given because all squared correlations between a construct and its indicators exceed the threshold of .5. Composite reliability (CR) estimates are above the recommended .7 cut-off value (see Table 1), suggesting the scales are reliable [67, 68]. In accordance with Fornell & Larcker [67] average variance extracted (AVE) should be above .5 and they range between .623 and .999 (see diagonal elements in Table 1) establishing the measures’ convergent validity. Discriminant validity is adequate if the AVEs (diagonal elements in Table 1) are greater than the squared correlations among the latent variables (off-diagonal elements in Table 1) [67] which is achieved with one exception. The squared correlation between attitude towards using ARS and perceived enjoyment exceeds the AVE of both constructs. This would suggest that they are not different. However, literature suggests that perceived enjoyment leads to a positive attitude towards using a system [46] which means that they are highly correlated. In addition, previous studies demonstrated the constructs’ discriminant validity [e.g., 52, 69]. These theoretical considerations and the reexamination of the measurement items lead to the conclusion that the constructs are sufficiently different from each other.

Table 1. Discriminant and convergent validity

<table>
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</table>

Note: AVE is reported on the diagonal

4.3. Structural model

Inspecting the structural model exhibits that the chi-square is significant (χ²=6695.082; p=.000). Further assessment of stand-alone and incremental fit indicators, however, suggests that data actually fits the model rather well. The TLI is .979 and the CFI is .982. So, they are well above the required level of .95 [70]. The RMSEA is at a satisfying level of .045 and the SRMR is .051.

The examination of the coefficients detects a significant effect of perceived ease of use on engagement and learning benefits as well as on perceived enjoyment. Furthermore, self-efficacy significantly impairs subject value and contrary to the proposed hypotheses the influence of self-efficacy on attitude towards ARS usage is negative. Subject value has an impact on the perception of engagement and learning benefits as well as on perceived enjoyment. Moreover, individuals’ enjoyment significantly affects the attitude towards using ARS which is found to be the strongest effect in the model. In addition, it influences perceived learning enhancement. Students who believe that an ARS is beneficial for engagement issues have a more favorable attitude towards using ARS. The relationship between learning benefits and learning enhancement is interesting because it is negative. This means that students who value the
learning benefits of ARS perceive that they do not experience a learning enhancement due to ARS usage. These results are summarized in a final model as shown in Figure 4.

The other hypothesized effects are not supported by the data. Table 2 provides a summary of all proposed hypotheses and the results from the analysis. Thereby, it displays the coefficients and the acceptance or rejection of the hypotheses.

Table 2. Proposed hypotheses and results

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Coeff.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: self-efficacy ⇒ learning benefit</td>
<td>.011***</td>
<td>rejected</td>
</tr>
<tr>
<td>H2: self-efficacy ⇒ attitude</td>
<td>-1.18*</td>
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</tr>
<tr>
<td>H3: self-efficacy ⇒ subject value</td>
<td>.396</td>
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<td>H4: subject value ⇒ engagement benefit</td>
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<td>H12: enjoyment ⇒ learning enhancement</td>
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<td>H17: learning benefits ⇒ attitude</td>
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</table>

Note: Significance levels: ***p < .01, **p < .05, *p < .1

Figure 4. Final model

5. Discussion and conclusions

5.1. Discussion and implications

This study provides empirical support of the positive effects of ARS and improves the current understanding of ARS usage.

First, and in line with Eccles & Wigfield [37] self-efficacy is found to impact subject value. This suggests that students value a subject higher for cases in which they feel competent to master the subject. Although others documented that self-efficacious students have a higher interest in carrying learning tasks [32, 34] the study’s results show that no relationship between self-efficacy and perceived learning benefit could be detected and that the relationship between self-efficacy and attitude towards using ARS is the other way round. This implies that students with doubts regarding their ability to pass the marketing course appreciate the ARS more and have a better attitude towards ARS usage. An explanation for this might be that bonus points for the exam are given and therefore, especially students who do not believe in their own capability appreciate ARS usage. Then, they do not have to gain as many points during the exam. Moreover, solved ARS questions in class could be a motivation for students with self-doubts by giving them a boost in self-efficacy. Another reason could be that the ARS usage reduces the pace of learning for self-efficacious students. For this reason, a further study with more focus on this subject matter is needed.

Second, a highly valued subject causes engagement in class activities [32, 39] and this study’s results are in accordance with that. Students with a high magnitude of subject value benefit from the application of ARS in terms of engagement and learning. Furthermore, the present findings corroborate the relationship of subject value and enjoyment reported by Tulisa & Ainleyb [38]. However, this research has been unable to demonstrate that subject value directly affects the attitude towards using ARS. The reason could be that students with greater individual interest in the topic presumably could gain similar benefits from alternative methods like normal questioning. Thus, the benefits may be less dependent on specific methods during the lesson. In this context it would be of interest if this suggestion is correct and if yes, which method is perceived to be the best one to gain the benefits mentioned. In addition, data collected on the characteristics of students could clarify if students who attend the course compared to students who do not attend the course have another level of subject value. Again, these are important issues for future research.

Third, current results are consistent with the idea of Davis [43] who suggested that user-friendly systems are considered to be more useful and thereby more beneficial. In addition, the current findings confirm that systems which are easy to use are also more fun to use [41, 42]. The correlation between perceived ease of use and attitude towards using ARS appears spurious and does not lend support to the causality as hypothesized by other scholars [e.g., 44, 45]. An explanation could be that the students of the course are already familiar with the learning management system and the mobile version of it. For this reason it does not have any impact on the attitude towards using the system in general. However, benefits and enjoyment can only be gained if a system is perceived as user-
friendly.

Fourth, it was hypothesized that enjoyment is a strong predictor of students’ perception of their learning enhancement due to the use of ARS and their attitude towards using the ARS. In fact, the strongest effect in the model is the one between perceived enjoyment and attitude towards usage. This supports previous research that highlights the important role of perceived enjoyment in the educational context [48] and that ARS are seen as a positive addition in class [18]. Therefore, application is recommended to other instructors.

Fifth, the beneficial engagement effect of ARS which in turn enhances students’ learning outcomes is not supported by the results and thus, is contrary to expectations. However, there is an effect on attitude towards using ARS. Basically, literature suggests that engagement results in better grades [5, 21, 71]. Apparently, it does not mean that the students develop this feeling whereat an enhancement of students’ actual grades could be achieved after all. Yet, a new interesting research field is spotted.

Sixth, an unanticipated finding was that perceived learning benefits do not have an impact on attitude towards using ARS and a negative one on perceived learning enhancement. A possible interpretation of this might be that students who discovered shortcomings in their current understanding would have needed more discussion and clarification on the results of the ARS questions. Since this desire was not fully fulfilled for them they perceived that the ARS does not help them to enhance their learning outcomes. Nonetheless, it is believed that these students will study more at home because they will try to catch up with their fellow students. In contrary, students who got a positive feedback which implies that they had the proof that their knowledge is sufficient and that they already have a thorough understanding of the concepts might believe that ARS questions do not enhance their learning since they already know everything. Once more, actual grades would be desirable to be able to compare the groups of students who used the ARS with the students who did not use it. In addition, it would also be fascinating to analyze the bonus credits achieved or the correctly answered ARS questions and combine these results with the current research model or the grades attained at the final exam. So, other studies will need to be undertaken to discover these effects. In addition, depth interviews could provide insights into the negative relationship and could test the above mentioned assumption.

5.2. Limitations and Conclusion

A number of important limitations need to be considered. It should be mentioned, that only students who attended the lecture were included in the sample. This might have resulted in an over-representation of students with a very high interest in the subject because attendance in the course is voluntary. Another problem is seen in the relatively small sample size which calls for follow-up studies with a larger cohort of students. Furthermore, a replication of the study with students from other disciplines is recommended to make the findings transferable.

Limitations notwithstanding, the current study, together with prior work, provides a good foundation for the claim that the usage of ARS offers benefits to students on several dimensions. It is perceived as enjoyable, beneficial to learning, and engaging whereas students’ perceived subject value and self-efficacy play a role in the evaluation these benefits. For this reason the ARS is perceived as an important instrument in our current educational environment.

References


[40] Davis, F.D., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology", *The


