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Linda Eckardt

Dennis Röske

Susanne Robra-Bissantz

University of Maribor Press

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LINDA ECKARDT, DENNIS RÖSKE & SUSANNE ROBRA-BISSANTZ

Abstract The belief in a just world can have an influence on the learning success of students because students who believe in a just world are willing to invest more time in learning. Previous studies have already shown that people who believe in a just world achieve better grades. However, measuring learning success using a single indicator does not provide sufficient information, because learning success depends on many factors (e.g. prior knowledge). For this reason, the influence of belief in a just world on objective and subjective knowledge changes is measured for a game-based learning application in this study with an online survey. The results of the study show that the students achieve subjective and objective knowledge gains. Nevertheless, not many significant correlations could be identified between the students' belief in a just world and objective or subjective knowledge changes. These results contradict previous studies that reduced the measurement of learning success to a single indicator.

Keywords: • Game-based Learning • Learning Success • Belief in a Just World • Knowledge • Serious Game •

CORRESPONDENCE ADDRESS: Linda Eckardt, Technische Universität Braunschweig, Chair of information management, Braunschwei, Germany, e-mail: linda.eckardt@tu-bs.de. Dennis Röske, Technische Universität Braunschweig, Chair of information management, Braunschwei, Germany, e-mail: d.roeske@tu-bs.de. Susanne Robra-Bissantz, Technische Universität Braunschweig, Chair of information management, Braunschwei, Germany, e-mail: s.robra-bissantz@tu-bs.de.

1   Introduction

A major learning challenge is to motivate learners, so that they are concentrated during the learning session (Laurillard 2002). Game-based learning (GBL) can be used to counteract this and describes the integration of game elements in education (Prensky 2001). Two design forms can be distinguished to create a GBL application: gamification and serious game. Gamification means to integrate only a few game elements in a non-gaming context (e.g. education) and a serious game is defined by the development of a full-fledged game with rules and objectives (Deterding et al. 2011).

With the integration of game elements in education, positive results can be achieved. For example, more fun and motivation or a positive influence on learning success (Eckardt & Robra-Bissantz 2018). However, learning success depends on various factors (e.g. motivation, knowledge gain or the quality of the learning application). Consequently, measuring learning success is difficult because it is more than the retention of facts, events or processes (Kerres 2001).

For example, people's belief in a just world (BJW) can also have an influence on learning success. Belief in a just world means that people always get what they deserve and deserve what they get (Lerner 1965). Accordingly, it describes the belief in a just or unjust world. As a result, it can be assumed that a person who believes in a just world tends to put a lot of effort into learning and therefore gains a lot of knowledge. Many conducted studies report an influence of BJW on learning outcome (e.g. Dalbert and Maes 2002; Peter et al. 2012), but in the context of GBL, to the best of our knowledge, the relationship was not analysed until now.

For this reason, the aim of this work is to analyze whether the students' sense of justice has an influence on the subjective and objective knowledge changes in game-based learning.

2 Related Work

In the last years, few studies have examined the meaning of belief in a just world and student's achievement (e.g. Dalbert 2013; Dalbert & Maes 2002; Peter et al. 2012). Some studies have already shown that learners who believe in a just world and feel, for example, treated fairly by their teachers perform better (Peter et al. 2012).

Generally, people have the need to believe that the world is just. However, a just world is a hope and not always given. Nevertheless, people need to believe in a just world to prevent a loss of control and a feeling of a fundamental senselessness about one's own life. Thereby, people are able to face long-term goals, to trust other people and to assign meaning to one's own actions (Hafer 2000). This forms the basis for action decisions and evaluations (Lerner 1977). The phenomenon that people usually assume that they live in a just world is called belief in a just world. He defines this belief in a just world as a world in which everyone gets what he deserves and deserves what he gets (Lerner 1965).

Generally, the personal BJW is based on three important functions. The first one is the motivation function. Belief in a just world ensures that we ourselves show just behaviour. This motivates people to achieve their objectives only by fair means. For example, self-exercised unjust action leads to a reduction in self-esteem for people with a strong BJW (Dalbert 2013). A further function is the assimilation function, which is important to attribute meaning to one's own actions. If people experience or observe injustice, they try to defend BJW. This happens by considering the injustice partly as self-inflicted, reinterpreting it, playing it down or denying it. BJW is maintained with the help of these strategies. The last function is the trust function, which ensures that people who believe in a just world trust that they will not experience injustice. After all, the invested work and time should also be profitable in the future (Dalbert 2013).

The belief in a just world is individual different (Rubin & Peplau 1975). The understanding develops in late childhood (Jose 1990) and remains largely constant over the years (Dalbert 2000). People with a strong BJW are willing to invest more time in their future (Zuckermann 1975). This applies in particular to the achievement of long-term goals, such as graduating with a good grade (Dette et al. 2004). This means that people with a strong BJW are willing to sacrifice

time from their leisure in favour of learning, so that they get better outcomes as a "fair result". This trust in fair treatment leads to a motivated willingness to learn and ideally to better grades (Peter et al. 2012). In contrast, people with a low BJW consider the use of a lot of time questionable, because it is not clear whether their investment in time is worthwhile and, for example, leads to higher learning outcomes (Peter et al. 2012).

Tomaka and Blascovich (1994) were among the first who analyzed the BJW in the achievement domain. In a laboratory experiment, participants should count backwards as quickly as possible in seven steps from a large number with as few errors as possible. The results showed that people with a high BJW initially saw this task as an interesting challenge rather than a threat. After completing the task, this group of participants reported that they felt less stressed than people with a lower BJW. As a result, the results were better, and they made fewer miscalculations. A further study supports these results. In the school context, Dalbert (2000) has found that students achieve better results in their core courses if they believe in a just world. Dalbert and Stoeber (2005) have found in two studies that a strong BJW is associated with fewer worries at school, better grades and a sense of fairly perceived assessments by teachers. Furthermore, a study of Dalbert and Maes (2002) showed a relationship between BJW and achievement motivation (pride in one's own performance, trust in success and an adequate level of ambition). The study by Peter et al. (2011) also showed that students who believe in a just world also perceive the behavior of teachers towards them as fair and receive better marks.

These results suggest the assumption that the BJW can be a great motivator and a necessary prerequisite for learning and thus decisive for knowledge gain. In the previous studies, the achieved learning success was determined by grades or retention rates. This often has a limited informative value, as it is only a snapshot of the performance. Previous knowledge or subjective knowledge gain are not considered. For this reason, this study analyzes the relationship between BJW and subjective and objective knowledge changes as part of learning success. This should lead to detailed results on the relationship between knowledge and BJW.

Probst et al. (2006) define knowledge as the whole of facts and skills that individuals use to solve problems. This includes both, theoretical and practical rules of everyday life. Knowledge is based on data and information, but in contrast to these, it is always bound to persons. Knowledge is created through the combination of information and its application. In this way, it becomes a skill (Mescheder & Sallach 2012).

In general, knowledge is distinguished between objective and subjective knowledge. Subjective knowledge means the assessment of a person's knowledge on a certain topic. This assessment can be made by a person himself or herself or by another person. The objective knowledge is the actually stored knowledge of a person, also known as factual knowledge (Brucks 1985).

There are several ways to acquire knowledge. This contribution is based on the acquisition of knowledge according to the theory of constructive alignment by Biggs (1999). Learning objectives, teaching and learning activities and an assessment of the achievement of learning objectives are thereby related.

3   Serious Game »Lost in Antarctica«

The GBL application used in the study of this paper is an open source point-and-click browser game to learn information literacy, specially designed for students of industrial engineering. The ability of a person "to recognize when information is needed and […] to locate, evaluate, and use effectively the needed information" is defined as information literacy (American Library Association 1989). In twelve levels, students learn topics of information literacy such as research strategies, scientific writing and copyright. For this purpose, students take part in a research expedition to the South Pole but their airplane crashes. Consequently, they need to repair their defective airplane in addition to their scientific work. The students get points for solving tasks. Achieving a certain number of points marks a successful level completion. Furthermore, students get a component for each completed level to repair the defective airplane. Students have the chance to exchange additional points on a market place through mini games that are just for entertaining purposes. The tasks to be solved are varying (Figure 1). Tasks to be solved alone (e.g. multiple choice, cloze texts, drag & drop, crossword puzzles, interactive system screenshots (Screen 1)) and tasks to be solved in a team (e.g. voting or case processing (Screen 2)) are integrated. This

playful form of learning is realized to motivate students to actively engage with topics of scientific work (Eckardt & Robra-Bissantz 2016).
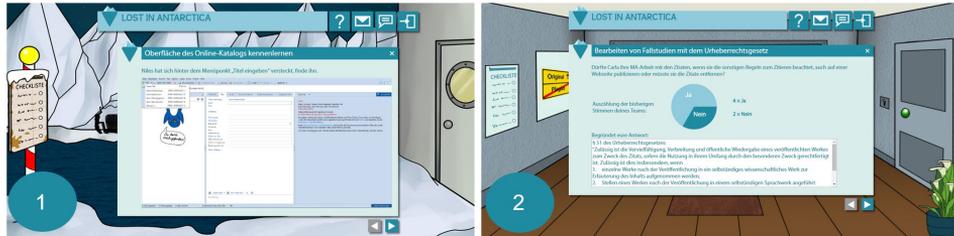
Figure 1: Screenshots of the serious game

4   Study on Belief in a Just World and Knowledge Gain

4.1   Study Design

The study will be conducted as an online survey. In the study, a data collection on subjective and objective knowledge and belief in a just world takes place in the context of a serious game. The online survey is carried out during the semester as part of a course for students of industrial engineering, in which they learn with the serious game how to work scientifically. Participation in the survey is voluntary and students receive no reward for participating. An online survey is carried out because students learn in the serious game independently of time and place and therefore a time-independent survey is necessary, e.g. to collect data about the current state of knowledge immediately after the learning process.

Before the students start with the serious game, previous knowledge of all learning contents in the serious game is checked and their personal belief in a just world is asked. In the middle and after the successful completion of the serious game, the knowledge of the students is collected again to determine changes in knowledge over the entire course. In the middle, only the contents already taught are asked and at the end again all contents.

Various methods exist for measuring BJW. In this paper, the scale of Lipkus (1991), which is based on the work of Rubin and Peplau (1975), is used and measured with a 6-point Likert scale (1 = fully disagree, …, 6 = fully agree). The reason for this is that the scale measures BJW general without limiting the focus

on a certain domain. Additionally, the scale consists of fewer items, which maybe ensures a higher response rate to the survey.

In the study, subjective and objective knowledge gain is analyzed, because the difference between the actual knowledge and what a person believes to know can be very big (Brucks 1985). According to Flynn and Goldsmith (1999), subjective knowledge is measured using a 6-point Likert scale (1 = fully disagree, …, 6 = fully agree). Students must answer questions on each topic of information literacy that is taught in the serious game for measuring objective knowledge. For each topic students are asked a question corresponding to a learning objective within the serious game, whereby the question types vary (e.g. multiple choice, free text, true/false, drag & drop).

4.2 Results of the Study

A total of 114 students took part in the study and 107 of them completed the survey at all three points of measurement. With 87 male and 20 female participants, predominantly male students took part in the survey. This is representative for the degree program of industrial engineering. All participants share approximately the same level of knowledge because they learn with the serious game how to work scientifically to write their final thesis. The age range of the surveyed students is between 18 and 32 years with an average value of 22 years and 2 months.

Belief in a Just World

Table 1 shows the mean values (MV) and standard deviations (SD) of all items of the belief in a just world scale.

Table 1: Belief in a Just World

No.	Item	MV	SD
1	I feel that people get what they are entitled to have.	4.25	1.26
2	I feel that a person's efforts are noticed and rewarded.	3.93	1.07
3	I feel that people earn the rewards and punishments they get.	4.36	1.14
4	I feel that people who meet with misfortune have brought it on themselves.	4.32	1.76
5	I feel that people get what they deserve.	4.31	1.3
6	I feel that rewards and punishments are fairly given.	4.36	1.43
7	I basically feel that the world is a fair place.	4.05	1.93

Most participants evaluate the belief in a just world as "rather agree", i.e. they tend to believe in a just world. With an average value of 3.93, the statement "I feel that a person's efforts are noticed and rewarded" achieved the worst result. Thus, not all participants believe to the same extent that the efforts of the individual are noticed. Item 3 and 6 achieved the best results. Participants therefore believe that awards and punishments are given fairly and that the people who receive them deserve them.

Subjective and Objective Knowledge

An analysis of variance with repeated measurements showed significant differences over the three measurement times for subjective knowledge ($F_{2,212}$ = 12,499, p = .000, partial $\eta2$ = .105). The results are shown in Table 2. Between the first and second measurement time as well as between the first and third measurement time a significant knowledge gain on a significance level of α = .05 can be determined. Learning information literacy took place between the measuring points exclusively with the serious game. For this reason, the knowledge gain is based on learning with the game. A twofold erroneous self-assessment could be the reason for no knowledge gain between the second and third measurement time. Incompetence often leads to an overestimation of one's

own abilities and with increasing competence one's own level of knowledge is underestimated (Kim et al. 2016).

Table 2: Results Analysis of Variance Subjective Knowledge

Time of Measurement (t= I)	MW (t = I)	SD (t = I)	Time of Measurement (t = J)	Δ I-J
1	3.05	0.96	2	-.460 *
			3	-.416 *
2	3.51	0.98	1	.460 *
			3	.044
3	3.47	0.96	1	.416 *
			2	.044

Different types of questions were used to determine the objective knowledge. This means that there was no uniform answer pattern and different methods had to be used for evaluation. Altogether the students were asked twelve questions, one for each game level and topic of information literacy with regard to the achievement of certain learning objectives. For example, in the level quoting and bibliographing students have to check the correctness of a quote. Due to the different response patterns, mean values and natural numbers were available for evaluation. Mean values were evaluated using variance analysis at three measurement points and T-tests at two measurement points, natural numbers using the Qochran-Q-test between the first and second measurement points, and the McNemar-test between the second and third measurement points. Table 3 shows the results for the objective knowledge. In four topics of information literacy (internet search, research strategies, good scientific practice and time management), students did not gain any knowledge. A loss of knowledge has even occurred when quoting and bibliographing. Students may have found it too difficult to check the accuracy of a quotation or may have guessed correctly at the time of the first survey. Guessing is a general challenge in verifying factual knowledge and can lead to bias of results, especially when right-wrong questions are used, as in the case of level citation and bibliography (Johann 2008). However, incomprehensible learning materials within the serious game can also have led to the loss of knowledge. In the other topics (publishing and open access, copyright,

literature management, scientific writing, scientific literature recognition, database search and catalogue search) students have significantly improved their knowledge.

Table 3: Results Objective Knowledge

Topic	t =1	t =2	t = 3	Δ_{1-2}	Δ_{1-3}	Δ_{2-3}	Values
Internet Search	0.464	0.539	0.533	x	x	x	$F_{2,212}$ = 2.342, p = .104, partial $\eta2$ = .022
Catalogue Search	25	72	74	□	□	x	T = 67.853, p = .000 $\hat{x}^2_{uncorrected}$ = .250, p = .617
Research Strategies	0.457	0.514	0.490	x	x	x	$F_{2,212}$ = 2.373, p = .109, partial $\eta2$ = .022
Database Search	70	89	91	□	□	x	T =18.318, p = .000 $\hat{x}^2_{uncorrected}$ = .250, p = .617
Scientific Literature Recognition	0.576	0.713	0.720	□	□	x	$F_{2,212}$ = 15.331, p = .000, partial $\eta2$ = .126
Scientific Writing	55	79	66	□	□	□ (-)	T =11.103, p = .004 $\hat{x}^2_{uncorrected}$ = .250, p = .617
Literature Management	19	-	74	-	□	-	$\hat{x}^2_{uncorrected}$ = 51.271, p = .000
Citation and Bibliography	58	-	36	-	□ (-)	-	$\hat{x}^2_{uncorrected}$ = 8.067,

							p = .0045
Copyright	22	-	64	-	□	-	$\hat{x}^2_{uncorrected} =$ 50.449, p = .000
Good Scientific Practice	3.196	-	4.521	-		-	T = .465, p = .643
Publishing and Open Access	-2.79	-	1.879	-	□	-	T = -8.958, p = .000
Time Management	41	-	44	-		-	$\hat{x}^2_{uncorrected} =$ 1.089, p = .2967

In the levels catalogue search, database search and scientific literature recognition, knowledge was even stored in long-term memory, because the students had no new learning phase with the game between the second and third time of measurement and there were no significant changes in knowledge. Especially in these levels there was a frequent repetitive use of the learned skills with similar task types, which may have led to a positive objective knowledge gain (Webb 2007).

Relationship between Belief in a Just World and Knowledge

The correlations of the mean value of BJW with the knowledge differences were determined according to Spearman. Here, the actual changes in knowledge are considered, i.e. the previous value is subtracted from the later time of measurement, so that there is a knowledge gain if the difference is positive. There is no significant correlation between BJW and subjective knowledge changes between the first and second time of measurement (r_{SP} = -.005; p = .962) and between the first and third time of measurement (r_{SP} = -.031; p = .754). Table 4 shows the correlations of each item of BJW with knowledge differences according to Spearman.

Table 4: Correlations BJW and Subjective Knowledge

Items BJW	Differences between first and second time of measurement		Differences between first and third time of measurement	
	r_{SP}	significance	r_{SP}	significance
1	-.017	.863	.048	.622
2	.080	.413	-.029	.767
3	.047	.634	.047	.630
4	-.196 *	.043	-.117	.231
5	-.033	.738	.048	.623
6	-.006	.951	.044	.654
7	.127	.193	-.007	.944

The table shows that the correlation is significant negative between subjective knowledge and the fourth item of the BJW "I feel that people who meet with misfortune have brought it on themselves". This means that participants who agreed with this statement show a lower subjective knowledge gain.

For analyzing the relationship between BJW and objective knowledge, only topics of information literacy with significant objective knowledge changes were considered. The correlations according to Spearman between the mean value of BJW and the objective knowledge differences showed no significant correlations for all learning contents. Furthermore, also at item level almost no correlations could be identified. A significant negative correlation (r_{SP} = -273; p = .004) could be identified between item 7 of the BJW "I basically feel that the world is a fair place" and the objective knowledge change. This means that participants who agreed with this statement have less objective knowledge gain in the field of citation and bibliography.

5   Conclusion

In this paper, not many connections between belief in a just world and the objective and subjective knowledge changes could be identified. Accordingly, students with a profound sense of justice do not seem to achieve higher subjective and objective knowledge gains.

These results are different in comparison to previous research results. Previous studies have shown that people who believe in a just world achieve better grades or have a higher retention rate (e.g. Tomaka & Blascovich 1994; Dabert & Stoeber 2006). This could not be proven in this study. One possible explanation is that in comparison to the other studies this study was conducted in the context of GBL and not in traditional course lectures. Furthermore, participants were different. In previous studies, school students participated instead of students of a university. Maybe that led to different results and should be analyzed in further studies. However, the achieved learning outcomes in this study were considered more extensively by measuring the objective and subjective changes in knowledge, because learning success was not reduced to a single indicator. Nevertheless, the results can only be generalized to a limited extent, because the interrelationships were only analyzed for a certain serious game and one learning topic. In further studies, it is therefore necessary to analyze the relationship between BJW and knowledge more detailed. This requires studies that analyze not only the changes in knowledge but also the achieved grade for the performance. This could provide more detailed information on the impact of BJW on learning outcomes. Additionally, the relationship should also be analyzed for other digital Game-based learning applications and other learning content to make the results more universal.

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