The Effects of Authenticity and Self-regulation: Comparing the Power of Innovative and Traditional Practical Simulations

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Traditionally, practical simulations were developed to train specific, routine-based, procedural and technical skills with the use of strict guidance of expert instructors. Nowadays in higher and vocational education, the emphasis increasingly lies on developing competencies (e.g. applying expertise or communication respectively). Powerful learning environments are being developed to stimulate the development of these competencies. The present study explores the effects of an innovative practical simulation (in which there is more authenticity and self-regulation; the key characteristics of powerful learning environments) on students' learning. Comparison of learning outcomes of 115 first-year Applied Biology students participating in an innovative or traditional practical simulation showed that they gained 5 out of 6 competencies. However, there were no differences between groups. Surprisingly, students in the traditional practical simulation scored higher on the transfer test and their simulation was perceived as more authentic than the innovative simulation. The discussion elaborates on possible explanations for the unexpected results and implications for designing powerful practical simulations.

Objectives

Practical simulations have increasingly become popular for professional learning in vocational and higher education. They promote transfer of learning from classroom to professional practice by deliberate practice, reflection and feedback (Maran & Glavin, 2003). Traditionally, practical simulations were developed to train specific, routine-based, procedural and technical skills with strict guidance of expert instructors and are still being used this way (Kneebone, 2005; Koskela & Palukka, 2011). However, the aim of modern education is not only to educate students to participate in working processes any longer, but also to train students to become professionals who can deal with a wide range of ill-structured problems in a competent way (Biemans et al., 2009). Consequently, professional education increasingly pays attention to developing competencies (e.g. applying expertise or communication respectively) (Hager & Smith, 2004). This paper aims to illustrate how implementing authenticity and self-regulated learning principles in practical simulations stimulate undergraduate students to develop competencies.

Theoretical Framework

To achieve the development of transferrable competencies, researchers and educationalist tend to increasingly focus on designing Powerful Learning Environments (Gijbels, van de Watering, Dochy, & van den Bossche, 2006; Winters, Meijers, Kuijpers, & Baert, 2009). Although the concept of powerful learning environments has become an umbrella term, literature suggests that learning environments are powerful when two key principles are implemented: first, the learning environment has to be *authentic* by including tasks, physical contexts and social contexts that resemble professional practice and second, it should

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stimulate students to *regulate their own learning process* (de Bruijn & Leeman, 2011; de Corte, 2003). However, there is little consensus about the authenticity and the extent to which practical simulations can actually stimulate self-regulative learning. Various studies have shown that students (McCaughey & Traynor, 2010) and teachers (Hotchkiss, Biddle, & Fallacaro, 2002) experience practical simulations to reflect professional situations, while an in-depth study showed that the social context of a practical simulation was not perceived to be authentic because student and client roles were unclear (Diamond, Middleton, & Mather, 2011). With respect to self-regulated learning, practical simulations are mostly characterized by teacher-provided structure which makes the organization of self-regulative learning in practical simulations a challenge (Maxwell, Mergendoller, & Bellisimo, 2004). Yet, Bryges et al. (2010) demonstrated that practical simulations in which students had some freedom of choice, led to more transfer of skills compared to completely pre-structured simulations. Maxwell et al. (2004) state that simulations could stimulate self-regulative learning when they are combined with ill-structured problems.

Present study will gain insights into the use of practical simulations for developing competencies by comparing learning outcomes of traditional practical simulations to the learning outcomes of innovative (authentic and self-regulative) practical simulations. The research question of present study is: How do innovative practical simulations influence undergraduate students' learning compared to traditional practical simulations?

Methods

Intervention

Undergraduate Applied Biology students participated in an innovative practical simulation or a traditional simulation. Table 1 shows how both practical simulation varied in authenticity and self-regulation.

Table 1. Implementation of an Innovative Practical and a Traditional Practical Simulation

	Innovative Practical Simulation	**Traditional Practical Simulation**
Authenticity	+ Tasks: authentic task (conducting a research in groups) and thematic sessions Physical context: task and thematic sessions took place in *one specific* nature reserve	-/+ Tasks: Isolated thematic sessions (e.g. simulating conducting research about flora, amphibians, insects) Physical context: thematic sessions took place *in various nature reserves* depending on theme
Self-regulation	+ Students: Several moments of choice (e.g. selecting theme of research according to interest, option to choose between thematic session) and half day free to complete research. Teachers: Structural coaching moments, less direct instruction, modelling and think aloud	- Students: Standardised assignments Teachers: More direct instruction, modelling and think aloud

Note. Implementation assessed with observations using the observation scheme for powerful learning environments (de Bruijn et. al., 2005).

The aim of both practical simulations was to learn to conduct applied biology research skills in nature, this is the main task of students' future profession.

Students in the *traditional simulation* followed isolated thematic (e.g. amphibians, butterflies) sessions for five days. During these sessions, students were placed in the role of researcher and applied various methods of conducting research in nature through standardized assignments and instruction and incidental coaching of an expert. Content and sequence of the sessions were pre-determined by the teachers and contained no self-regulative moments. Tasks and physical environment lacked some authenticity; the traditional simulation did not fully resemble the real work of a biology researcher because the tasks did not include research tasks like planning, reporting and sharing information. The learning environment was also less authentic because the sessions took place in various nature reserves. For example, butterfly-sessions took place in a nature reserve where many sorts of butterflies could be found. Normally, biologists conduct research in *one* nature reserve to find relations between flora and fauna.

Students in the *innovative simulation* were stimulated to integrate separate themes and all steps of biology research in a meaningful way by working constantly on a complex, authentic assignment. The assignment was to answer a research question (e.g. 'What flora is present in the nature reserve and what is the impact on the wildlife?') in groups of 4-5 students by conducting research in a specific nature reserve. Thematic sessions were comparable to the traditional simulation, except that students had to apply their gained insights to their authentic assignment. The authentic assignment was completed with a presentation. With respect to self-regulative learning, several moments of choice were planned: 1) students could choose the theme of the research, 2) during a number of thematic sessions, students were free to choose between two themes and 3) the first half of the fifth day was fully self-regulative (e.g. extra session, finishing authentic assignment). The design of the experimental simulation was also characterized by structural coaching moments.

Participants

In spring 2011, first-year Applied Biology students (N=115) from a University of Applied Sciences in The Netherlands, participated in the practical simulations. Students were randomly assigned to the traditional simulation (control group) or the innovative simulation (experimental group). Several students did not show up or did not complete the pre-test and post-tests, this resulted in a sample of 51 students in the control group (mean age 19.8, 51% men) and 45 students in the experimental group (mean age 19.02, 64.4% men). A Chi-Square test indicated that the gender of the participants was independent from intervention (χ^2 (1) = 1.77, p = 0.07).

Materials

Observations. To examine whether the intervention was implemented as intended (an innovative simulation based on the principles of powerful learning environments), two researchers conducted observations using the observation scheme scales of De Bruijn et al., (2005). This scheme was designed to observe to what extent authentic and self-regulative learning takes place and to what extent the learning environment provokes traditional learning (e.g. decontextualized, direct instruction). The model distinguishes three components of powerful learning environments; program characteristics, student learning and guidance. Powerful and traditional program characteristics, student learning and teacher guidance were observed for two full days by two researchers. Program characteristics were scored (1- not applicable, 2-somewhat applicable, 3-applicable) in consensus at the end of each day. Student and guidance activities were tallied separately and scored in consensus (1-not observed to 5-observed very frequently) at the end of each day.

Self-assessments. Before and after the practical simulations, students assessed themselves on six competencies researching, applying expertise, using materials, writing and reporting, presenting and co-operating. The competencies were based on the competencies of Bartram (2005) and was adapted to the context of secondary and higher vocational education (Khaled, Gulikers, Oonk, Biemans, & Lans, 2011). Each competency consisted of four to seven items on which students rated their competence (ten-point scale, 1-not competent to 10-very competent). An example item of the skill 'Applying expertise' is 'I am able to perform routinely tasks without any problems' and for the competence 'cooperating' 'I help my peers with their tasks'.

Final exam. Students' overall competence of an applied biologist was tested with final exam. The exam required students to describe a research plan setup for one out of four pre-determined research questions (e.g. 'What factors affect the flora present in dead wood?') in a research report. The exams were corrected by three teachers (score 1-10).

Transfer measure. The month after the simulations, the students had to finalize an authentic project. At school and together with a real client, the students had to conduct a research. The content of the projects varied a lot, but was highly related to the practical simulation sessions. For example, a group of students had to monitor the population of a specific amphibian. Their final research report (mark 1-10) was used as transfer measurement for this study.

Learning environment perceptions were measured directly after the simulations. Authenticity of the simulations was measured via nine items, on a scale of 1-strongly disagree to 5-strongly agree, about the tasks and physical and social context of the practical simulations (e.g. 'The tasks of the training resembled the task an applied biologist') (Gulikers, 2006). Because we operationalized self-regulation in the innovative simulation mainly by giving students opportunities to choose for topics of interest and to choose between tasks, we measured self-regulation by five items of the Perceived choice scale of the Intrinsic Motivation Inventory (e.g. 'I had little choice about what tasks I could perform', 1- not true at all to 7-very true) (Ryan & Deci, 2000).

Data Analysis

For the analysis we used SPSS version 19. Mean scores of the observations were calculated, a repeated measure ANOVA was conducted to examine whether the two groups differed on their competence development and independent *t*-tests were used to compare the differences of scores on the final exam, transfer task and students' perceptions.

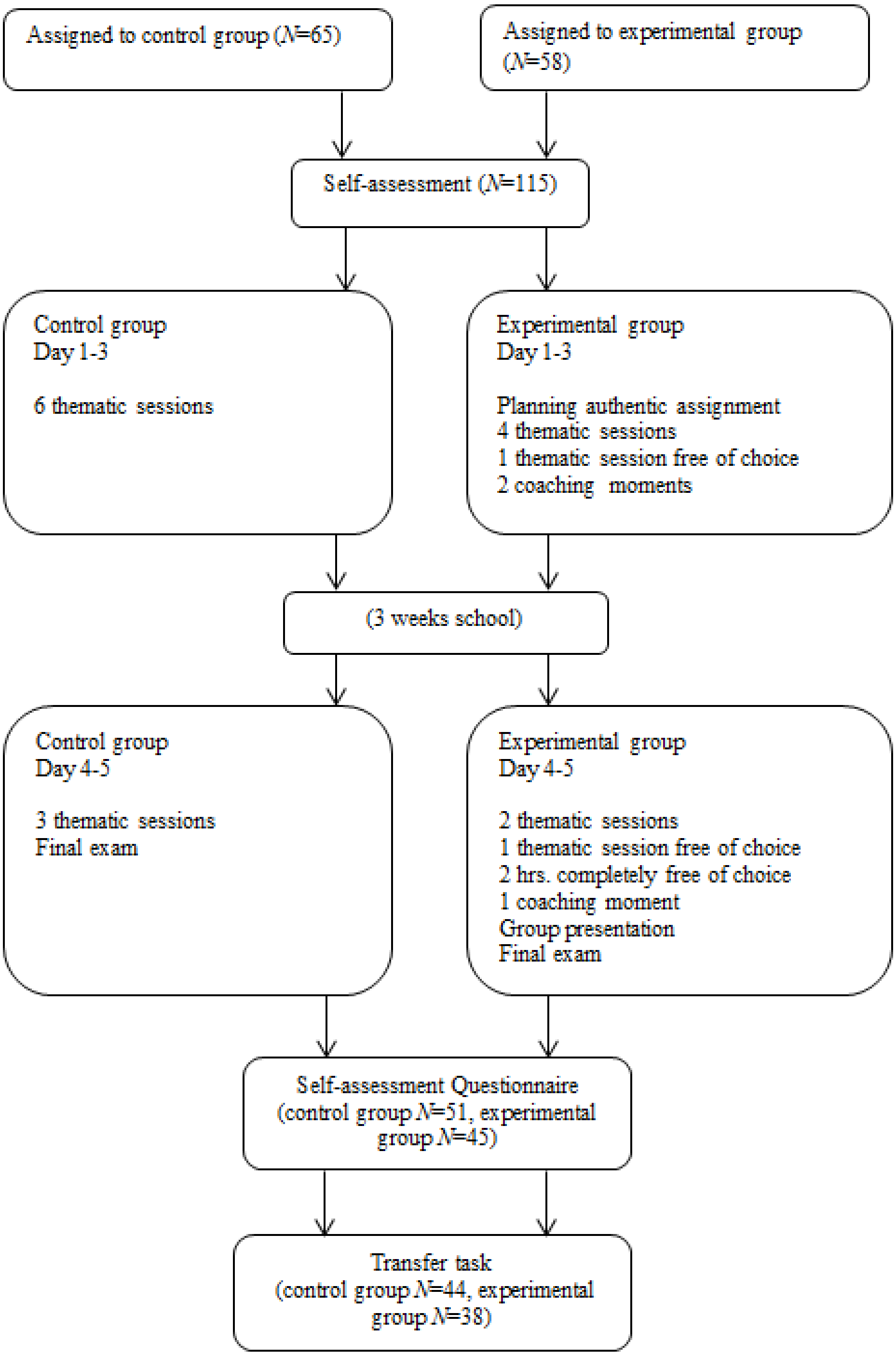

Figure 1. Design of study.

Results

Observations. As shown in the observations, the implementation of the innovative simulation (i.e. key characteristics of powerful learning environment) was more or less successful. Regarding the program characteristics, the implementation was as intended; higher observation scores on powerful program characteristics for the experimental condition was observed (Table 1). However, powerful student learning and guidance was not implemented to the extend the researchers had planned. More powerful *and* traditional student learning activity was observed in the control group. Both groups received almost the same amount of powerful guidance, while, the students in the control group received more traditional guidance, and thus more guidance in general.

Table1
Outcomes observations

	Range	Control group Mean	Experimental group Mean
Program characteristics			
Powerful characteristics (authentic, integrative, broad range of resources, educational tools, materials and locations)	1-3	1.91	2.30
Traditional characteristics (subject oriented, decontextualized, minimal stimulus)	1-3	2.30	1.64
Student learning			
Powerful student learning (cooperative learning, self-regulation, reflection)	1-5	1.93	1.71
Traditional student learning (standardization, individual learning, repetition of knowledge and procedures)	1-5	3.62	2.50
Guidance			
Powerful guidance (adaptive instruction, coaching, stimulate self-regulation, feedback)	1-5	1.85	1.90
Traditional guidance (direct instruction, modelling, think aloud)	1-5	2.92	2.00

Self-assessments. Both groups scored higher on the post-test compared to the pre-test on the six competencies. These differences were statistically significant, except for the competency ‘co-operation’ (Table 2 and 3, main effect). However, there was no test-by-group interaction for all measures on vocational and generic skills which means that statistically, both groups equally gained competence.

Table 2
Mean scores self-assessments

	Experimental group		Control group	
	Mean Pre-test	Mean post-test	Mean Pre-test	Mean post-test
Vocational skills				
Researching	6.65	7.13	6.83	7.43
Applying expertise	6.16	6.75	6.35	7.00
Using materials	6.81	7.26	6.76	7.47
Generic skills				
Writing and reporting	6.39	6.90	6.62	6.93
Presenting	6.36	6.81	6.45	6.71
Co-operating	7.26	7.42	7.42	7.52

Table 3
Results repeated measures ANOVA

	Main effect	Test x group interaction
Vocational skills		
Researching	$F(1,94)= 41.32$, $p<0.001$	$F(1,94)= .61$, $p= .438$
Applying expertise	$F(1,94)= 35.50$, $p<0.001$	$F(1,94)= .07$, $p= .794$
Using materials	$F(1,94)= 28.00$, $p<0.001$	$F(1,94)= 1.39$, $p= .242$
Generic skills		
Writing and reporting	$F(1,94)= 28.93$, $p<0.001$	$F(1,94)= 1.97$, $p= .164$
Presenting	$F(1,94)= 18.43$, $p<0.001$	$F(1,94)= .33$, $p= .252$
Co-operating	$F(1,94)= 2.19$, $p=.142$	$F(1,94)= .17$, $p= .683$

Final exam. The experimental group did not score significantly higher on their final exam (M =7.00, SD= .89) compared the control group (M = 6.92, SD= .92) ($t\ (94)= .42$, $p=.67$).

Learning environment perceptions. Results of the *t*-tests show that the experimental group (M = 3.61, SD = .41) perceived the learning environment significantly less authentic than the control group (M = 3.77, SD= .33) ($t(94) = -2.14$, $p = .035$) and experienced the same amount of free choice (M=4.22, SD=.87) compared to the control group (M = 4.13, SD= .85) ($t(94) = .531$, $p= .597$)

Transfer assignment. The experimental group scored significantly lower (M = 6.65, SD =.76) on the transfer task compared to the control group (M = 7.09, SD= .72) ($t(80)=-2.67$, $p<.01$).

Conclusions and Discussion

The results of present study show that undergraduate students gained competence (except for co-operative working) through participating a practical simulation. The students scored their selves rather high on cooperation skills before the start of the simulation sessions, which could explain why there was no gain in cooperation through participating the practical simulation. Contrary to our expectations, adding authenticity and self-regulation to the simulation did not lead to more competence development compared to the traditional simulation. More surprisingly, students in the traditional simulation perceived the simulation to be more authentic and scored higher on the transfer task than students in the innovative simulation. Several explanations are suggested for the findings.

First, students in the innovative simulation did not perceive more free choice than students in the traditional simulation although free choice moments were explicitly planned. Also observations suggest that students in the innovative simulation showed less learning activity. This could have been the consequence of drastically reducing traditional guidance (e.g. direct instruction) and not compensating with other forms of support. The effect of guidance should not be underestimated because the absence of appropriate teacher guidance in a self-regulative learning environments can lead to less motivation and student learning (Katz & Assor, 2007).

Second, the innovative simulation was less authentic to the students probably because these students have another image of their future profession. In this study there clearly was a mismatch between the perceived authenticity of the designers (teachers and researchers) and the students. Students imagine the profession of an applied biologist to be exciting (e.g.

frequently finding extraordinary species) and varied (e.g. moving from one nature reserve to another) all the time (like in the traditional simulation), but did not take into account that planning and presenting research also is an important aspect of the profession (like in the innovative simulation). These issues relate to the question: To whom should a learning environment be authentic? (Hay & Barab, 2001). In case of first-year students, authenticity perhaps resembles broadness of what the profession has to offer and therefore feel the need to explore a broad range of variety of tasks related to the profession. Complex, whole tasks in simulations are maybe more fitted for second- or third year- students who gradually experienced what their profession entails. The fact that the traditional simulation was more varied could also explain why students in the traditional simulation showed more transfer. From a behaviouristic point of view, variation in examples of what has to be trained is one of the most important conditions for transfer (Baldwin & Ford, 1988).

We should also take into account that implementation of innovative learning environments heavily depends on teachers' skills and beliefs about the concepts of the intended innovation (Guskey, 1986). Therefore, we are training the teachers of (innovative) practical simulations about authentic and self-regulative learning and start a second research cycle in 2012.

Significance

This research shows that pedagogical principles that are being concerned as important these days, do not automatically lead to more learning. These principles have to be considered very carefully and need more research underpinning their surplus value, especially in case of practical simulations. Thereby, this study was conducted in close cooperation with teachers who stated that being a part of this study made them reflect on their learning strategies.

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