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Serious game in introductory psychology for professional awareness: Optimal learner control and authenticity

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Abstract

Introductory Psychology courses in Higher Education lack application of knowledge in solving work-based problems. We develop and study mini-games that support a more active and experiential way of learning to increase professional awareness. This paper describes the instructional design and the factors under study: learner control and authenticity. We compared professional awareness and perceived authenticity for the old (without game, n = 130) and new course (with game, n = 197) by administering pre- and post-questionnaires. Participants were allocated to game variants, differing in freedom of assignment order (less or more learner control) and number of sources available (less or more authentic). We computer logged their game actions, and asked them additional questions about gameplay that concerned aspects like motivation, flow, performance, learnability and usability. Both courses improved professional awareness (knowledge gains of 4% for the old and 12% for the new course), but only in the new course with mini-games this was significant. Students evaluated gameplay and their content as "more than sufficient" to "good." A free order of assignments was found to produce more effective (in-game) performance, and the provision of more sources was found to improve learnability, authentic learning and appreciations of gameplay.

Introduction

Active learning through meaningful and playful practice has shown to positively influence students' professional awareness (eg, Boersma, ten Dam, Volman, & Wardekker, 2010; Meijers, Kuijpers, & Gundy, 2013; Sherman, Sebora, & Digman, 2008). Positive effects of acquiring more transversal skills (that are not specifically related to certain jobs or domains) on both professional awareness, and as a consequence commitment during academic and professional careers, have been reported. When students have more concrete ideas of their own interests and preferences, they can better engage with future careers. Such "professional games" provide a

Practitioner Notes

What is already known about this topic

- Active and more experiential learning can contribute to the acquisition of professional competences.
- Learner control has been found to be a factor of importance when designing more active and experiential learning, but optimal level and conditions need to be further researched.
- Authenticity of the learning context has been found to be a factor of importance when students should acquire professional competences, but optimal level and characteristics need to be further researched.

What this paper adds

- Well-designed, scenario-based professional games effectively increase the professional awareness in (beginning) psychology students about their future study specializations and work.
- Increasing the level of learner control in deciding upon the sequence of assignments in game play was found to improve the performance effectively.
- Increasing the amount of resources in game play was found to improve feelings of more authentic learning and game appreciation.

Implications for practice and or policy

- Serious games that combine similar authentic scenarios (learning mechanisms) with gaming mechanisms, as were used in our instructional design, can be expected to be useful if practitioners want to improve professional awareness in their (beginning) students (in various domains).
- Learner control is an important factor to be considered by practitioners when designing serious games, especially regarding the sequence control of learning activities.
- Authenticity of the learning environment is an important factor to be considered by practitioners when designing serious games, especially regarding the variety (richness) of resources provided.

learning context that simulates the context in which students will apply their learning. In that way, learning activities become more relevant and motivating, and increase the likelihood that acquired skills will actually transfer to real-world situations (Herrington, Oliver, & Reeves, 2003; Hoekstra, 2011). Such gaming or playful learning in context is recognized as an activity that can enhance students' motivation to learn and lead to better learning results when compared with more traditional learning (eg, Boyle *et al*., 2016; Garris, Ahlers, & Driskell, 2002; Wouters & van Oostendorp, 2013). The remainder of this introduction is split into three parts: a review of studies about game-based learning (Section 1.1); a review of literature about the central constructs of "learner control" and "authenticity" (Section 1.2); and a presentation of the games and research questions under study (Section 1.3).

Game-based learning

A recent literature review (Zhonggen, 2019) on serious games over the last decade shows that, especially since 2015, numbers of empirical studies have been increasing. Enjoyment and motivation were *not* found to be *influencing* factors for learning outcomes, although this often is thought to be the case; the other way around they *are* reported as *resulting* factors from gameplay,

next to improved learning and efficiency outcomes (All, Nunez Castellar, & Van Looy, 2015). Overall, researchers report the need for a general evaluation framework for quality assessment of serious games, and some frameworks have been suggested (eg, Hainey & Connolly, 2010; Mayer, 2012). Adequate relationships between learning attributes and gaming mechanics were found to be critical for the quality of instructional (game) design and desired learning outcomes, and some models for their mapping have been elaborated (eg, Arnab *et al.*, 2015; Carvalho *et al.*, 2015). Dimensions reported for learning processes that need to be considered in the game design are: learner modeling and profiling, including learner control; pedagogic approach for supporting learners; representation of the game; and context in which the game takes place, including authenticity of learning environment and tasks. Embedded support and assessment (also referred to as internal or stealth assessment) as part of gameplay has been found particularly important for skills acquisition (eg, Caballero Hernández, Palomo Duarte, & Dodero, 2017).

This study focuses on two important aspects of dimensions reported in review studies: learner control and authenticity. Active learning involves the learner in control of activities aimed at self-directed learning (Freeman *et al.*, 2014). Situated and authentic learning provides the learner with meaningful experiences through "rich media" presentation formats (Herrington *et al.*, 2003). As with more active learning, a "richer" or more authentic context is assumed to contribute to more sustained and self-directed learning. Both aspects of learning link to the idea that motivation initiates and sustains learning (only) if adequate learner support is given (Michael, 2006; Sherman *et al.*, 2008), and that initial motivation arises from well-designed authentic tasks or experiences (Ritterveld, Cody, & Vorderer, 2009; Ryan & Deci, 2000). We now continue this introduction by summarizing what literature tells us about the concepts of learner control and authenticity, and how we have operationalized these constructs in the game variants under study.

Learner control and authenticity

Defining optimal "learner control" and "authenticity" to the satisfaction of all researchers and educators is nigh impossible. We discuss definitions and aspects in relation to game-based learning.

Learner control

Learner control (LC) is the degree to which learners can direct their own learning experiences and are given control over certain aspects of their learning processes, like the sequence, content, pace and instructional approach (Hannafin, 1984; Steinberg, 1989). Since the emergence of computer-based instruction (Intelligent Tutoring Systems and Adaptive Hypermedia), flexible interaction of learners with instructional materials and more learner control have become within reach (Friend & Cole, 1990). Although the potential of LC to improve learning and motivation is appealing, there still is no conclusive support for this assumption (Karich, Burns, & Maki, 2014; Landers & Reddock, 2017; Sorgenfrei & Smolnik, 2016). Empirical studies with LC yield mixed results, reporting both advantageous effects (eg, Swaak & de Jong, 2001) and adverse effects (eg, Scheiter & Gerjets, 2007), so it is safe to assume that LC works better under certain conditions.

Sorgenfrei and Smolnik (2016) carried out a meta-analysis on LC and concluded that: "In most cases, LC is more likely to be favorable when learners (1) know about the topic, (2) have high cognitive and self-regulatory abilities, (3) prefer an autonomous learning process, (4) have a positive attitude toward the task and are motivated to accomplish it, and (5) when the tasks are simple rather than complex" (p. 169). Hannafin (1984) stated that LC is likely to be most effective in the following conditions: (1) higher age of the learners, (2) learners with higher ability, (3) familiar content, and (4) where the LC is accompanied by advisement to assist learners in making appropriate decisions. Corbalan, Kester, and Van Merriënboer (2009) defined three conditions that should be met for an effective use of LC: (1) learners should be skilled for dealing with the offered

degree of LC, (2) learners should have free cognitive resources, since LC imposes additional load on cognitive processing and (3) LC should be noted by the learners.

The insight that LC is a multi-faceted construct has inspired several researchers to develop theoretical frameworks to distinguish types of LC (Landers & Reddock, 2017; Sorgenfrei & Smolnik, 2016). The framework by Landers and Reddock (2017), that inspired our current study, organizes dimensions of LC accross three broad types of LC: (1) instructional control in changing the content (skip, supplement, sequence, pace, practice and guidance control), (2) style control in changing the presentation mode (ie, control of esthetic training characteristics) and (3) scheduling control to decide on the when and where of instruction (time and location control). Landers and Reddock concluded that they can only recommend the use of sequence control as this type of LC yielded most consistent findings, where findings on the other two types of LC were mixed or contradictory. It is the only dimension that has either a positive or no effect on all outcomes. Sorgenfrei and Smolnik's meta-analysis of LC comes to a similar conclusion: sequence control by the learner is most likely to have positive effects on learning outcomes.

This paper reports the findings of our study that researched if providing students sequence control over the order of assignments within mini-games improves their acquisition of professional awareness. Each of the (16) mini-games consists of (four) assignments. Game variants did not differ on style- or scheduling control of assignments.

Authenticity

The learning philosophy grounded on cognitive apprenticeship (Lave & Wenger, 1991) should be researched in relation to situated (Brown, Collins, & Duguid, 1989), experiential and authentic learning (Ashford-Rowe, Herrington, & Brown, 2014; Herrington & Oliver, 2000; Perkins, 2010). According to Gulikers, Bastiaens, and Kirschner (2004), Gulikers, Bastiaens, Kirschner, and Kester (2008), authenticity is defined by the extent to which real-life professional situations are reassembled in a learning environment. Studies have revealed benefits of authenticity (Herrington & Oliver, 2000; Reeves, Herrington, & Oliver, 2002) in terms of motivation and preparedness for future work. Students reported feelings of enhanced self-efficiency, usefulness (Hursen, 2016) and enjoyment (Aiken & Day, 1999; Ernst, 2013). Studies dealing with authenticity found learners to develop their knowledge (Hramiak, Boulton, & Irwin, 2009) and improve their ability to apply theory to real world contexts (Ernst, 2013).

Despite such positive effects, there remain several challenges when designing authentic learning environments to bridge the gap between theory and practice. For example, Gulikers *et al.* (2004, 2008) assert that authenticity is a rather subjective concept (placed in the eye of the beholder) and that perceptions of authenticity influence student learning. Negative perceptions occur when learners feel that programs did not provide "real" experiences (Aiken & Day, 1999) or when they perceive learning as being too time and energy consuming (Hramiak *et al.*, 2009). Such challenging aspects of authenticity are also reflected in the fact that the influence (whether facilitating or hindering) depends on the way the learning process is designed (Radović, Hummel, & Vermeulen, 2019).

The optimal alignment and design of authentic learning tasks with an optimal "professional proximity" can be done based on Gulikers *et al.*'s (2004) five-dimensional framework or the 10 characteristics of authentic activity provided by Reeves *et al.* (2002). Gulikers *et al.* distinguish five dimensions of authenticity, namely: (1) the *task* that resembles the *complex inquiry* with respect to the integration of knowledge, skills and attitudes; (2) the physical context that reflects the way knowledge, skills, and attitudes will be used in professional practice; (3) the social context

that reflects social processes that are present in real-life contexts; (4) the assessment that involves a multiple indicator of learning in order to come to fair conclusions and (5) the criteria based on standards used in the real-life situation (Gulikers *et al.*, 2004, 2008).

Reeves *et al.* (2002) distinguished 10 broad design characteristics of authentic learning activities (or tasks), based on a wide literature review of recent research and theory. Authentic tasks: (1) have real-world relevance; (2) are ill-defined, and problems inherent in the activities are ill-defined and open to *multiple interpretations* rather than easily solved by the application of existing algorithms; (3) comprise complex activity and information to be investigated by students over a sustained period of time, requiring *significant investment of time and intellectual resources*; (4) provide the opportunity for students to examine the task from different perspectives, using a *variety of resources*, that offer a variety of theoretical and practical perspectives, requiring students to detect relevant from irrelevant information; (5) provide the opportunity to collaborate; (6) provide the opportunity to reflect on their learning both individually and socially; (7) can be integrated and applied across different subject areas and lead beyond domain-specific outcomes; (8) are seamlessly integrated with assessment in a manner that reflects real world assessment, rather than separate artificial assessment removed from the nature of the task; (9) create polished products valuable in their own right rather than as preparation for something else and (10) allow for competing solutions and a diversity of outcomes.

This paper reports the findings of our study in which we researched if providing students with more sequence control over the order of assignments and with more authentic resources in the mini-games would improve their (game-based) learning and feelings of authenticity. (The old) "Introduction into Psychology" course of our Master in Psychology was considered to be too theory-driven and in need of a more practical orientation, and was, therefore, revised into (the new) course with mini-games (added for more authentic and active learning); as a consequence of adding these games, the total studyload for the course was increased from 7.5 to 10 EC. Besides the inclusion of these games, both the old and new courses used a textbook (psychological theory) in combination with a "digital work book" (assignments about that theory). Just the content was actualized, but the (didactical) format of learning activities instructed by the work book remained the same, so did *not* provide any more authentic or active learning activity. All course materials were offered through our home-brew LMS. Our university offers open distance education through online learning programs, that mostly do not contain more traditional (in person) lectures or (face to face) work groups, also absent in this course. We both compared (1) the learning outcomes and appreciations after studying the old course (without games) with these results after studying the new course (with games), and (2) the learning outcomes and appreciations between game variants within the new course. The game variants differed on the degree of learner control within each game (fixed or free order of assignments) and the amount of background resources available within each mini-game (from just one for every assignment to about four for every assignment). Providing a larger variety of intellectual resources from different sources was expected to cater for a "more complex inquiry" on the task level (according to Gulikers *et al.*, 2004, 2008), and especially to cater for the fourth characteristic of having multiple perspectives (and indirectly also the second and third characteristics of having ill-defined problems and more complex tasks of longer duration) as presented by Reeves *et al.* (2002).

Mini-games and research questions

The instructional design of our games departs from an overarching scenario that connects authentic cases from professional practice to authentic learning tasks, represented through

16 scenario-based mini-games (of which 12 were available and researched at the time of this study). At the basis of the scenario lies a multi-facetted problem family that is to be analyzed and treated from four main psychological perspectives that are offered as specializations in our Master program Psychology (clinical psychology, labor and organization psychology, life counseling psychology and health psychology). Professional competences practiced by carrying out practical assignments within the mini-games (each takes approximately 1.5 hours to study) are for example: how to communicate with patients; how to conduct tests and therapies in actual practice; how to conduct an anamnesis during intake; how to build and analyze client files; and how to deal with practical dilemmas, useless information and unexpected events.

All scenarios have been worked out in close collaboration with domain experts from our faculty of Psychology. Elaborated scenarios were implemented and worked out into mini-games using our home-brew and dedicated EMERGO approach and platform for developing and distributing professional games for experiential learning (Nadolski *et al.*, 2008). This approach follows three design stages: a first analysis phase where a predefined set of questions is answered (like what will be the target group, the main learning objectives and the narrative of gameplay); a second phase in which the so called "framework scenario" is designed that further describes the learning tasks, the functional components of gameplay, the main characters, resources and tools, etc; and a third phase in which a "detailed scenario" is worked out. That detailed scenario contains all instructional, dialog and feedback texts, as well as the -links to- concrete resources and tools to be used. Information from the detailed scenario is then implemented into the components. There are, among others, reusable components for interviews, resources, locations, tooling and for scripting the narrative in the EMERGO authoring environment.

Scenario-based mini-games make students play an active and explorative role in authentic professional settings, which is expected to increase professional awareness and involvement. Gameplay supports students in finding out more about their values, beliefs and strengths (personal identity), and in finding out more about interesting specializations and preferred career options, as well as tools and networks to get there (professional identity). Where authentic cases show overlap, mini-games can have a collaborative or integrative nature between specializations.

Figure 1 provides some more concrete insights into the mini-games. The four screengrabs depict: (upper left) (a) the 12 mini-games with respective domain experts, as well as the virtual supervisor (on the right); (upper right) (b) a list of assignments available within a mini-game, with the first assignment always being an interview with the domain expert; (lower left) (c) an assignment in which the student has to analyze and categorize video fragments of an intake interview; and (lower right) the dashboard that presents individual competence growth on generic and domain-specific professional competences and apparent preferences for specializations (the latter available after 75% of gameplay).

Research questions

We carried out an experimental study with three main research questions:

1. Does playing the mini-games affect professional awareness and perceived authenticity of what the work of psychologists entails?
2. Does offering more flexible study paths (more learner control) affect learning and satisfaction with gameplay? and
3. Does offering more resources (more authenticity) affect learning and satisfaction with gameplay? The next section will describe the research design of this study in some more detail.

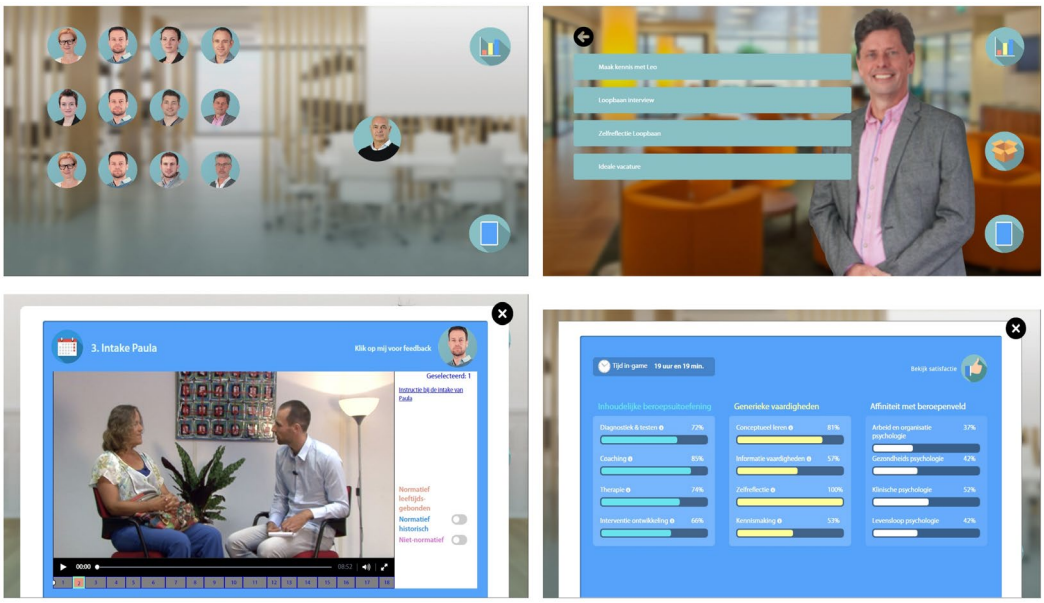

Figure 1: Screengrabs from mini-games for psychology awareness
[Colour figure can be viewed at wileyonlinelibrary.com]

Method

To answer research question 1, we compared professional awareness and perceived authenticity achieved through the old course (without games) and the new course (with games), by surveying the last batch of students taking the old course ($n = 130$ participants) and the first batch of students taking the new course ($n = 197$ participants), and analyzing answers given by both batches to questions about psychological practice and authenticity before and after studying the course. To answer research questions 2 and 3, we compared learning- and satisfaction effects of different game variants, by comparing the final grades (learning effect) obtained, and by analyzing differences in answers given to various additional questions after studying the course about various aspects of gameplay (indicating perceived satisfaction effects), like flow, learnability, usability and motivation.

Participants taking the old course were directed to the questionnaires from our LMS (Learning Management System). When participants, taking the new course, decided to start gameplay (a mandatory component of the new course), as well as agreed to participate in the study (by informed consent), our LMS redirected them to the EMERGO player environment, from where they were randomly allocated to a game variant (thus creating equal-sized and homogeneous groups). As already mentioned (in Section 1.2), the game variants differed on (A) the degree of learner control within each game (fixed or free order of assignments) and/or on (B) the amount of background resources available within each mini-game (from just one for every assignment to about four for every assignment), yielding three experimental conditions (group "A + B+" with both free order and more resources; group "A + B−" with free order without more resources; and group "A − B+" with fixed order and more resources) and a control group "A − B−" with fixed order without more resources.

Before starting and after ending gameplay, EMERGO redirected them to a pre- and post-questionnaire, both implemented and delivered in LimeSurvey. Students taking the old and new course answered questions from an (identical) sets of questions about professional psychology practice and about perceived authenticity, but the set of items for the new course was much larger since many items specifically deal with (the evaluation) of gameplay as an additional set of measures of perceived satisfaction. The post-questionnaire for participants in the new course also measured students' satisfaction with flow, authenticity, motivation, learnability, usability and their satisfaction (with gameplay) as dependent variables. Grades on final exams for both courses could be compared as objective learning effect measure.

Questionnaires

The 16 multiple-choice questions about *psychology practice* were developed by members of our own Psychology staff. For both the old and new course a random set of eight items was selected for the pretest and posttest questionnaires, and deltas were calculated for the differences between average scores on the posttest minus pretest as measure for growing professional awareness. For other outcome measures, we used 5-point scales. Only items related to perceived authenticity could be compared between old and new course; other outcome measures were related to gameplay. We used all 23 items of the validated e-flow questionnaire (Fang, Zhang, & Chan, 2013) to measure perceived *flow* in online learning. For this study we have developed 19 items to measure perceived *authenticity*. We used 13 items of the validated Intrinsic Motivation Inventory (IMI) questionnaire (Ryan & Deci, 2000) to measure *motivation*. We have used nine items from a validated questionnaire (Nadolski & Hummel, 2017) to measure *learnability*, have used six items from the validated Usability Metric for User eXperience (UMUX) questionnaire (Lewis *et al*., 2015) to measure usability, and have developed seven items to measure *attitude towards playing games*. In order to calculate the internal consistency and to compare average scores on all scales, all questionnaire items using All scaled responses to items were (re)calculated in the same direction (from "totally disagree" to "totally agree"), and maximum scores were standardized to 100% (or 100 points) maxima. Cronbach's alphas found were "good" to "excellent" for all 5-point scales respectively $\alpha = .920$ for flow, $\alpha = .937$ for authenticity, $\alpha = .931$ for motivation, $\alpha = .762$ for learnability, $\alpha = .834$ for usability and $\alpha = .811$ for attitude; and based on the variance of scores they all appear to have discriminative power. Average scores on the scales could, therefore, be used for further analyses. Finally, students were asked to evaluate the game content (EVALUATE_CONTENT) and gameplay (EVALUATE_GAME), scored on a 10-point scale. All items of these scales are provided as Appendix to this paper.

Logging data

A dedicated research data component of the EMERGO authoring environment logged and extracted various gameplay activities as potentially interesting dependent variables. For this study we have looked into total *playtime* (in hours), the number of *revisits* to games (REVISITS_GAME) and assignments (REVISITS_ASSIGNMENT), the amount of *(extra) resources opened* (OPENRESOURCE_NR, EXTRARESOURCE_NR) with the average time (in minutes) they were open (OPENRESOURCE_TIME, EXTRARESOURCE_TIME), the number of *deviations from* the (standard) *order of assignments* (DEVIATIONS_ASSIGNMENT) and *an in-game performance score* (PERFORMANCE). This performance score is based on monitoring all errors made during gameplay and later transformed into 0–100% scores, with a 100% score indicating that no errors were made by student (most efficient learning) and a 0% score indicating "random behavior" (or less) by student (least efficient learning), scores that are depending on the number of alternatives (nAlt) and amount of errors (nErr) for each activity. All assignment activities (total of

48 assignments, some having two or more sub assignments) were monitored, including a variety of tools like for answering MC questions, multi-select options, to categorize items (using drag-and-drop tools), for selecting text fragments, to generate pie charts, for axis-positioning and others. Finally, we unobtrusively obtained (at the end of each assignment) student assessments of *attractiveness* (NICE_ASSIGNMENT) and *task complexity* (COMPLEX_ASSIGNMENT) of assignments that were scored on a 6-point scale.

Grades

After completing gameplay, participants had to take two partial exams to finish the course, both constituting half of the final grade (GRADE). Students completing the old course just did one final exam; students completing the new course received an average grade over two partial exams. At the time of writing of this paper, for most participants (92%) their final grades were available.

Data collection and analyses

Raw data from LimeSurvey, EMERGO and university's student administration were collated into an Excel sheet and stored securely to warrant student privacy by the principal investigator. An anonymized dataset (excluding student numbers) was imported into SPSS (version 24) were additional transformations (eg, redirecting negative item scores, calculating averages) and statistical analyses were carried out.

Results

In this section we first present the statistical descriptives of all dependent variables under study (Section 3.1) as overall impression. To answer research question 1 (Do games affect professional awareness and perceived authenticity?), an independent samples *t*-test compared both courses, and a paired samples *t*-test established a treatment effect of gameplay in the new course (Section 3.2). To answer research questions 2 and 3 (Does more or less learner control and more or less authenticity in games affect learning and satisfaction?), various univariate tests of variance (ANOVA's) tested for effects of condition on dependent variables, and we include effect sizes (partial eta squares) when significant differences were indeed found between game variants (Section 3.3).

Descriptives

Table 1 presents an overview of statistical descriptives (minimal and maximal scores, means and standard deviations) for all dependent variables as could be obtained from both questionnaires and computer logging over all conditions of gameplay ($n = 197$). In this table only the descriptives of final grade ($n = 303$) and (perceived) authenticity ($n = 301$) can be reported for both courses (as was explained in the method section).

Overall, the average *play time spent* on playing the 12 mini-games is 17.26 hours (like we expected when designing the mini-games), although we see a lot of variance between students (ranging from about 4 to 50 hours). Participants generally report that they appreciate *authenticity, motivation, learnability and usability* of playing the games with average scores between 66.53% for motivation (more than sufficient) and 76.29% (good) for usability. *Flow* is evaluated as sufficient (moderate) with an average score of 62.75%, again with substantial variance between students. *Content and gameplay* are evaluated with averages around 7.33, again with substantial variance between students. The average attractiveness of assignments can be considered as "moderate to high" ($M = 3.84$) and the average complexity can be considered as "low to moderate" ($M = 2.56$).

Participants that had freedom to change the *order of assignments* hardly made use of this, with a maximum of only 12 deviations (DEVIATIONS_ASSIGNMENT). Participants that had the

Table 1: Descriptives for main dependent variables (n = 197)

Dependent variable	*Min*	*Max*	*M*	δ *(SD)*
PLAYTIME (total, in hours)	3.78	50.22	17.26	8.67
REVISITS_GAME	0	76	10.19	11.23
REVISISTS_ASSIGNMENT	0	96	11.00	10.16
OPENRESOURCE_NR	17	130	74.08	21.21
OPENRESOURCE_TIME (avg, in min)	0.83	14.20	4.79	2.43
EXTRARESOURCE_NR	0	13	.53	1.77
EXTRARESOURCE_TIME (avg, in min)	.00	26.59	.34	2.04
DEVIATIONS_ASSIGNMENT	0	12	.68	1.79
NICE_ASSIGNMENT	1.02	5.81	3.84	.93
COMPLEX_ASSIGNMENT	1.00	4.54	2.56	.70
PERFORMANCE	43	79	63.31	6.63
FLOW	20.00	90.43	62.71	12.55
AUTHENTICITY (n = 301)	21.05	100.00	71.52	12.78
MOTIVATION	26.15	98.46	66.53	16.41
LEARNABILITY	43.33	100.00	70.95	11.01
USABILITY	20.00	100.00	76.29	14.88
ATTITUDE	31.43	100.00	70.72	12.85
EVALUATE_CONTENT	4	10	7.32	1.24
EVALUATE_GAME	1	10	7.34	1.77
GRADE (n = 303)	3	10	7.24	1.11

possibility to open extra sources hardly made use of this, with a maximum of only 13 extra resources opened (EXTRARESOURCE_NR). Finally, observed scores for in-game PERFORMANCE (M = 63.31%) are sufficient, again with much discriminating variance between participants.

Treatment effect of games

This section presents results to answer research question 1 (is there a game effect on professional awareness and perceived authenticity?). For both courses, participants demonstrate an increased awareness of professional practice after having studied the course, as reflected by the increased number of correct answers on work-related questionnaire items after completion (a delta with M = 0.63 and δ = .07). A closer inspection shows that this delta is only 0.025 (a 4% increase in awareness) for the *old* course (increasing from M = 6.37 to M = 6.67) and 0.094 for the *new* course (12% increasing from M = 5.95 to M = 6.90 group average). An independent samples t-test shows this (overall) course effect to be indeed significant: $t\,(303) = -2.522$, $p = .012$. Within the *old* course itself, this increase is *not* significant. A paired samples t-test comparing scores of participants in the *new* course, between pre- and post-questionnaire items about psychological practice, *does* show a (highly) significant treatment effect for including games: $t\,(192) = -5.846$ and $p < .001$.

When comparing the final grades for both courses, another objective measure of learning effect, we also see a difference in favor of the new course. Where the group average (n = 130) for the old course is M = 7.08 (δ = 1.012), for the new course (n = 173) this is M = 7.36 (δ = 1.161), with $F\,(1, 301) = 4.602$, $p = .033$, $\eta_p^2 = 0.015$ as course (game) effect. When comparing average scores for perceived authenticity of the old and the new course, we also see a higher average score for the new course, however this difference was not found to be significant.

Different effects between game variants

This section presents results to answer research questions 2 and 3 (are there effects of more or less learner control and more or less authenticity in games on learning and satisfaction?). Most average scores for dependent variables measured (see Table 1) appear not to differ significantly between groups. The univariate analyses of variance we have run, with experimental condition (game variant) as independent variable, only yield significant effects for (in-game) performance scores, perceived learnability, perceived authenticity and appreciation of gameplay as dependent variables. For all other dependent variables (see Table 1), no significant differences between game conditions were found.

More learner control by free assignment order

In response to research question 2 (effect of learner control), we found an effect of gaming condition on the (in-game) *performance scores* (F (3,193) = 3.799, p = .011, η_p^2 = 0.056). When regrouping participants in one group "A+" containing both groups having learner control over the order of assignments (with M = 64.98 and δ = 7.31), and one group "A−" containing both groups having no learner control (with M = 61.85 and δ = 5.61), this difference even becomes highly significant (F (1,195) = 11.508, p = .001, η_p^2 = 0.056), with a medium effect size (according to Cohen, 1988). We found A+ groups to spend some more total playtime (with M = 17.41 and δ = 9.57) than the A− groups (with M = 17.09 and δ = 7.56), but this difference is not significant.

More authenticity by adding sources

In response to research question 3 (effect of authentic resources), we encountered significant differences, with small to medium effect sizes, when similarly combining and comparing one group "B+" (containing both groups having access to some more additional sources per assignment) with one "B-" group (containing both groups having one source per assignment) for *perceived authenticity* (F (1,191) = 4.630, p = .033, η_p^2 = 0.024), for *perceived learnability* (F (1,191) = 4.654, p = .032, η_p^2 = 0.024), and for the *overall appreciation of game play* (F (1,191) = 7.097, p = 0.08, η_p^2 = 0.036).

Conclusion

Regarding our *first* research question (Does playing the mini-games affect professional awareness and perceived authenticity?), we may conclude that playing the mini-games is indeed appreciated by participants as a more motivating and authentic learning alternative, and that by playing students (more effectively) increase their level of professional awareness and complete their courses with a higher grade. This finding is in line with research showing that meaningful and playful practice positively influences students' professional awareness (eg, Boersma *et al.*, 2010; Meijers *et al.*, 2013; Sherman *et al.*, 2008). Regarding our *second* research question (Does offering a more flexible study path (more learner control) in games affect learning and satisfaction?), we found that providing more freedom to decide on the order of assignments might indeed be beneficial for more efficient learning (as was found for better in-game performance). However, no effect of learner control on satisfaction was found. This finding is in line with meta-studies on learner control (eg, Landers & Reddock, 2017; Sorgenfrei & Smolnik, 2016) concluding that (only) providing sequence control as type of learner control had positive learning effects. Some researchers attribute beneficial effects of such learner control to increased intrinsic motivation caused by its autonomy-supportive nature (Keller, 1983; Ryan & Deci, 2000). Regarding our *third* research question (Does offering more resources (more authenticity) in games affect learning and satisfaction?), providing more background sources was found to contribute to a sense of more efficient- (perceived learnability scores) and authentic learning (perceived authenticity scores), as well as

to the overall appreciation of gameplay (perceptions that can be considered as positive effects on satisfaction), however no learning effects were found. This finding can be considered to back up Reeves' *et al*. (2002) fourth guideline on designing authentic learning activities, ie, that students should be provided with a variety of resources (from different perspectives, and requiring them to detect relevant from irrelevant information).

These interesting results are to be taken with some caution due to the limitations of the current state of the course and study. *First* of all, most reported effects of gaming factors studied are of small effect sizes, which might be due to relatively small numbers of participants (41 to 54 per condition, a total of 197 gamers provided complete datasets), where around 280 gamers would have guaranteed sufficient effect sizes. *Secondly*, the grouped within-game interventions "A+" (more learner control) and "B+" (more authenticity) appear to be relatively small (in relation to the game design as a whole, as will be clear from the complexity of factors described in the theoretical sections on "learner control" and "authenticity"), and might, therefore, have been scarcely noticed and/ or used by gamers. For instance, it appears that many gamers did not notice the presence of the "extra sources" option (that was presented as additional button on the screen), since only about 20% of gamers in the "B+" conditions have made use of it. *Thirdly*, skipping assignments or changing their order might not always be the most efficient way of more active learning *when* assignments are related or (partly) build upon each other. By skipping these assignments, students might then miss relevant information.

We need to continue this study with larger numbers of participants and/ or with much larger differences between conditions, eg, by providing even less structure in one condition or by providing clearer access to even more additional sources. Besides, to increase professional awareness was only one objective of including games in the course. Another objective was to make students more interested and committed to continue their study. We have some indications that drop-out rates are indeed decreasing and throughput data are improving, but more quantitative information is recommended. We would also like to include some more qualitative data on learners' experiences with students to be able to explore their perceptions in more depth. Notwithstanding these constraints and still missing data, this study provides other empirical evidence for the enormous potential that professional games hold for more experiential education and further research in this area.

Insights gained from this study give further direction to using educational technology in practice. For incorporating the optimal level of authenticity in technology-enabled learning environments, we have to encounter an optimal balance between a very high level of authentic learning (more appealing but very costly to develop and implement) and a very low level of authentic learning (not that appealing but also less costly to develop). Among their suggestions for further research on learner control, Landers and Reddock (2017) also mention the importance of investigating more complex relationships, such as interactions between various types of objective learner control, between learner characteristics and objective learner control, or the optimal balance between system control and learner control. Where Corbalan *et al*. (2009) propose a shared control approach (like in this study), others prefer learner control over system control with the system only suggesting adaptive support and decisions for the learner (Bunt, Conati, & McGrenere, 2007). For Educational Technology research the insights from this study provide direction to further developing a theory and practice of using collaboration scripts (CSCL), in which the responsibilities of both learning system and learners (and their peers and tutors) can be defined and researched. Finally, the didactic scenarios and gaming mechanics developed in the serious game under study have already appeared to be of generic value and interest as an educational technology template for game-based learning for all those that want to increase

professional awareness and commitment (also in other domains than psychology), and it would be interesting to see how similar game development and empirical studies could be replicated in other domains to further generalize these finding.

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Statements on open data, ethics and conflict of interest
Our Ethical Committee approved the research plan (warranting data protection and anonymized data) for this study on 23rd of June 2015. That plan also arranges access to our research data through an institutional repository. Open access and free use of these research data will be granted when required for educational (and non commercial) purposes.We report no conflict of interest with this study.

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APPENDIX: QUESTIONNAIRE SCALES AND ITEMS

Scale "Flow"

1. Playing this game challenged me
2. Playing this game could provide a good test of my skills
3. I find that playing this game stretches my capabilities to my limits
4. I was challenged by this game, but I believed I am able to overcome these challenges
5. I knew clearly what I wanted to do in this game
6. I knew what I wanted to achieve in this game
7. My goals were clearly defined Mijn doelen waren duidelijk omschreven 3
8. While playing this game, I had a good idea about how well I was doing
9. I was aware of how well I was performing in this game
10. I receive immediate feedback on my actions
11. My attention was focused entirely on the game that I was playing
12. When playing this game, I was totally concentrated on what I was doing
13. When playing this game, I felt in control over what I was doing in the game
14. I feel comfortable with the controls of this game
15. I often find myself doing things spontaneously and automatically without having to think
16. When I play the game, I feel I am in a world created by the game
17. I kind of forgot about myself when playing this game
18. I lost the consciousness of my identity and felt like "melted" into the game
19. When I played this game, I sometimes felt like things were happening in slow motion
20. When I play this game, I tend to lose track of time
21. Playing this game is rewarding in itself
22. I loved the feeling of that performance and want to capture it again
23. I enjoyed the experience

Scale "Authenticity"

1. The game provided me with sufficient information about issues in psychology
2. After playing this game I know better what to think about the work of a psychologist
3. By playing I gained more insight in the issues involved in the psychological context
4. The game allowed me to practice my skills in with issues in the psychological context
5. The game made me experience real-life issues and apply knowledge in context
6. The game makes you study and apply the content in an active way
7. The game learns you to apply your knowledge in a practical context
8. The game urges me to reflect and take initiative
9. The game allowed me to study content from various perspectives and to apply independently
10. Within this game I could determine whether I learned enough
11. The game made me experience in a nice way what the issues in the psychology practice involve
12. My awareness of the psychology practice was increased in an attractive way by playing the game
13. This game in fact makes you experience problems with the psychology practice in context
14. Playing the game made me feel more involved with the professional domain
15. Playing the game makes you experience content and practice in context
16. Playing this game learned me that practical problems require an integrative approach
17. Playing this game learned me that solving practical problems is complex
18. Playing this game learned me that there are no simple solutions to practical problems
19. Playing this game learned me that practical problems often are not clearly laid out

Scale "Motivation"

1. Enjoyed a lot playing this game
2. The game was fun to do
3. Playing this game was boring
4. The game has not got my attention at all
5. Would like to describe this game as interesting
6. Put in a lot of effort when playing the game
7. Was important for me to do well while playing the game
8. Worked hard when playing the game
9. Believe this game has been useful for me
10. Believe that playing this game will be important for my future life
11. Think playing the game will help me in making future decisions
12. Think this game is important
13. Played this game because I did not have a choice

Scale "Learnability"

1. The assignments in the game are complex and challenging enough
2. It was not made clear enough what was expected of you to do for playing the game
3. The game content misses relevant content
4. The game misses sufficient feedback
5. The available feedback is very useful
6. The game should contain more hints and help

7. The explanations with the assignments were clear enough
8. The game provides enough structure for efficient learning
9. The game provides sufficient opportunity to test your knowledge
10. The game provides sufficient opportunity to test practice
11. Knew on what I woud be assessed while playing the game
12. Playing, learning and assessment are well integrated in this game

Scale "Usability"

1. *The* options for operating the interface are well explained
2. Operating this game can sometimes be a frustrating experience
3. Operating this game is easy
4. When operating the game I had to spend much time correcting
5. Feel I had enough control when playing the game
6. The options for operating the game are according to my needs

Scale "Attitude"

1. Found the game to have the right balance between learning and playing
2. Flexibility in a game is important
3. Games like this make the subject matter more interesting
4. Games like this make the subject matter more understandable
5. This game complies to what I feel an ideal game should be like
6. For doing the assignments the game provided me with sufficient sources of information (documents, video, audio, et cetera)
7. Feel playing the game takes too long