Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-52-AC1, 2016

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Learning about water resource sharing through game play" *by* T. Ewen and J. Seibert

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Received and published: 8 July 2016

RC1 comment 1: The paper documents a range of games available and how one particular game, Irrigana, appears to be developing as a learning platform. The sample size on which the analysis is based is small and further analysis would be useful in future to support the conclusions drawn.

AC1 reply: We agree that the sample size is small if one looks on the number of teachers who shared their experiences with Irrgania. However, each of these teachers represents ca 10-50 students, which means that the experiences are based on many people all together. For the future we plan to continue collecting feedback from Irrigania users in order to increase the sample size, and support the conclusions drawn in this paper, but obviously a significant increase of the sample size will take quite some time

(years)

RC1 comment 2: To provide more context for those unfamiliar with Irrigana, it would be useful to provide example input scenarios, decisions and outcomes, preferably visualised, to help the reader appreciate more fully the value and potential of the game.

AC1 reply: We had discussed whether to put in specific game scenarios from Irrigania, but decided that including a reference to the original paper by Seibert and Vis was likely sufficient. Given this helpful comment, we will include two scenarios with game decisions and outcomes in the revised manuscript to help the reader better understand how the game is played, and potential scenario outcomes.

RC1 comment 3: More importantly, to support the evaluation of game play benefits, it would be useful to include the survey questionnaire used. Similarly, including the survey results as a table would be useful to clarify the description of the evaluation.

AC1 reply: We weren't sure on the format for including both the questions and responses from the survey and agree that this could be improved. As suggested by the reviewer, we will include a table in the revised manuscript with the survey questions and summary of survey results.

RC1 comment 4: The paper also presents an evaluation of the benefits to learning about water resource sharing derived from developing games. This element of the paper needs to reviewed; the paper would be improved if it identified the specific points of student learning on water resource sharing that have been derived from developing new games.

AC1 reply: We thank you for this helpful comment. In the paper, we briefly discuss (in the "Discussion and Conclusions" section) what types of learning the students gained from their game development, including: soft skills, critical thinking, problem solving, team work and time management. We agree with the reviewer that these points could be further discussed in the paper. In the revised manuscript we will elaborate on these

skills and highlight the most important learning outcomes, based on both the feedback from the students and our assessment of the course. Although we touched on learning outcomes in other games, we will now tie in the feedback we received with findings from the literature we cited, to further support the discussion.

RC1 specific comment 5: Section 2, Irrigania as a teaching tool Page 2, Line 25 - The text notes that Irrigana assumes "...cost of groundwater increases with increasing depth to groundwater." It would be useful to understand the basis on which this depth increases, presumably the amount and duration of pumping. In this context, it would also be useful to understand how any interactions between groundwater rivers are represented. These points may be covered by Siebert Vis, but a brief comment here would help appreciate the conceptual hydrological system represented in Irrigana and therefore, to what scenarios the game can be applied.

AC1 reply: The cost per field of irrigating with groundwater is given by: for g < 8 : 20 and for g $\geq$ 8 : 20 + (g–8)2, where g is the depth to groundwater (in arbitrary units of the order of m) and dependent upon the amount of precipitation during a given year (determined by a "precipitation indicator" where a normal year = 1; a dry year = 0; and a wet year = 2) as well as the number of fields irrigated with groundwater. In contrast, the cost of irrigating with river water is fixed at 20, but the revenue depends on the precipitation indicator(0;1;2), the number of fields irrigated with river water, and the number of farmers in the village. This is described in detail in Seibert and Vis, but we will now include a short description of this so the reader can better understand outcomes of different scenarios between different resources used. RC1 specific comment 6: Page 2, Line 26 - The text states maximising income is the goal of the game, while previously revenue is mentioned. To improve clarity it would worth being specific that the income is net of farmer costs, if this is the case, and differs from revenue. AC1 reply: This is a very good point, and see that we've used the two words interchangeably, but in fact only revenue is considered in Irrigania. We will adjust the text so it is correct. RC1 specific comment 7: Section 2.1, A survey of using Irrigania: Although

there were few respondents to the survey, it would be useful to understand where all of the Irrigana users were based, whether they responded or not. This would provide extra information on the geographical spread or restricted distribution of responses and so the international penetration of Irrigana as a learning tool.

AC1 reply: This is a very good point, we have this information from the survey and can include it.

RC1 specific comment 8: It is important to include the survey questionnaire used to underpin the results presnted and conclusions drawn. Although this may take up a significant amount of space, it would be useful as the questioning is multi-stage and not simple to follow with a text- only description. It would help as well to present the survey results as a table, including the number of respondents at each stage of the questioning. This should help make the results more accessible to the reader and enable an appreciation of the confidence in the conclusions that have been drawn. This would also help the explanation of results on page 4 line 17-18 and on page 5 line 21-28.

AC1 reply: We agree, and as written above in response to the reviewer's general comment on this, we will include this information as a table so it's clearer.

RC1 specific comment 9: The use of brackets rather than commas can be a matter of personal preference, but in Section 2.1 this results in parts of the text being awkward to read. A particular example to address is on Page 4, Line 16 where nested brackets are used, but are incomplete. To aid the reader, I'd suggest that this and other sentences be reworded to allow many of the brackets to be removed.

AC1 reply: Thank you for this comment, we will reword these sentences and remove the brackets.

RC1 specific comment 10: Section 3 Page 6, Line 12, reference to Figure 1 - Suggest spiltting Figure 1 left and Figure 1 right into separate figures. This would help enable

an explanation/translation of the German text labelling to be included. Unfortunately, the text is inaccessible for those unfamiliar with German.

AC1 reply: We agree and will split these figures and include the translation of the German text in the caption for (the current) Figure 1 left.

RC1 specific comment 11: Page 6, Line 13, reference to Figure 2 - It is useful to have Figure 2 included to illustrate game development, but referencing of Figure 2 left (Line 21) and Figure 2 right (Page 7, Line 1) needs to be clarified. For example, it's unclear if there should be a reference to Figure 2 middle and if so, it's very unclear what Figure 2 left actually illustrates and what it adds to the documentation of game development.

AC1 reply: Thank you for noticing this. The figure numbers are incorrect in the text and the references should be to Figure 1 left and right and not Figure 2 left and right. We will correct this in the text.

RC1 specific comment 12: Page 6, Line 25, reference to Figure 3 - Including an explanation/translation of the German labelling would help understanding of the Wiapuna game.

AC1 reply: We agree and will put a translation of the German text in the caption.

RC1 specific comment 13: Page 7, Line 12, reference to Table 1 - Column headers include Price/year and Yield/year, but the units for price and yield are no specified. If the intention is that they are dimensionless and illustrative in the context of the game, then this needs to be clarified.

AC1 reply: These values are given in arbitrary units of money, thank you for pointing this out. We will add this to the text (and Table 1 caption).

RC1 specific comment 14: Section 3.1, Evaluation of learning outcomes The key messages from game development seem to relate mainly to insufficient time, planning challenges and need for re-timetabling of other course modules. This is interesting, but the evaluation would benefit from documenting more substance on the value and bene-

fits to learning about water resource sharing derived from the games developed. In this context, the conclusions on the game development state that the "students had to think through the intricacies and complexity of water resource sharing, as they thought through players' moves and water resource outcomes", but there is no detail on what these intricacies and complexity were. This is in contrast to the learning experiences from using Irrigana noted in Section 2.1, which at least highlights that the learning has been that "cooperative behavior and communication were both key to succeeding".

AC1 reply: Thank you for this helpful comment. In addition to the points mentioned above (reply to comment 4), we will include more text and explanation on the learning outcomes (now outlined in the discussion), and relate these more clearly to the "intracacies and complexity" that we mentioned in Section 3.1. We also thank you for the point about comparing this to Irrigania, and think it would be worth adding some text to link the learning experiences from both Irrigania and the student developed games. This was overlooked and including this will help to strengthen the paper.

RC1 specific comment 15: It would improve the paper's contribution if it identified the specific points of learning on water resource sharing that have been derived from developing the games.

AC1 reply: Yes, we agree and will add more discussion on this as outlined in the comments above (replies to comments 4, 14).

RC1 technical correction 16: Page 1, Line 23 - Reference to Johnson, 2012 should either be Johnson et al. or the paper is missing from the reference list.

AC1 reply: Yes, this is incorrect and should refer to Johnson et al. (2012). We will correct this in the text.

RC1 technical correction 17: Page 2, Line 20 - To improve clarity, suggest rewording as follows, ".... role of cooperation in, and competition for the use of water as a limited common-pool resource"

AC1 reply: Thank you, we will reword this.

RC1 technical correction 18: Page 3, Line 15 - Reference should read Lecoutere et al. (2015)

AC1 reply: Thank you for noticing this, we will correct it.

RC1 technical correction 19: Page 5, Line 21 - Rewording suggested as follows "Additional analysis was carried out considering user data collected since July 2013, when user histories began to be saved; this excluded data collected during our own use of Irrigana. This was done to further analyse how ....."

AC1 reply: We will reword following the suggestion for clarity.

RC1 technical correction 20: Page 7, Line 7 - Insert "a" as follows, ".....Heins (1994), as a way to show.."

AC1 reply: Thank you for noticing, we will include this.

We thank Michael Jones for his very careful review of our paper and his valuable comments. We think that by including his more substantial comments on the Irrigania questionnaire, and further clarifying the learning outcomes, the manuscript will be substantially improved.

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