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getFeedback!: Feedback-Based Learning while Identifying a Caravan Site Location

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Abstract. A new teaching and learning approach has been implemented in the BSc course Geodata - Geoinformation - Geoknowledge. This course is part of both the Geography and Geoinformatics bachelor programmes at the Faculty of Informatics at the University of Augsburg. In the course we combined a case study with a new tool - getFeedback! - that allows both tutorial and peer feedback. In the case study students had to find an optimal location for a caravan site. It was divided into the following tasks: identification of criteria for the location of a caravan site, identification of data sources for the criteria, and design of the analysis workflow including GI methods. In addition, tutorial and peer feedback was provided using the getFeedback!-Tool. Students were asked to complete a pre- and post-test to assess learning. Analyses of the test results showed that the more tasks students completed, the better they performed on the post-test. We conclude that getFeedback! combined with a case study is a valid tool to support students in the acquisition of professional competences.

Keywords. Tutorial Feedback, Peer Feedback, Case Study

1 Introduction

"Active teaching and learning is the way forward in educating students in geographical information (GI)" (van Loenen et al., 2023, p.1). As part of a research project, a new tool called getFeedback! has been implemented as a plugin in the interactive learning platform at our university. The tool allows both tutorial and peer feedback. We used it in the BSc course Geodata - Geoinformation - Geoknowledge which includes a lecture and an exercise where students acquire theoretical knowledge. This knowledge is then applied in a case study where the students have to find an optimal location for a caravan site. It is divided into the following tasks: identification of criteria for the location of a caravan site, identification of data sources for the criteria, and design of the analysis workflow including GI methods. In addition, tutorial and peer feedback was provided using the getFeedback!-Tool. As part of the project, we conducted a pre-test and a post-test with the students in order to evaluate the effectiveness of the tool. We wanted to find out whether students who participated in the case study would outperform students who only did the lectures and exercises.

In the remainder of the paper we introduce the getFeedback!-Tool (Section 2) and the case study (Section 3). Section 4 elaborates on the pre- and the post-test. In Section 5 we analyse the results. We close the paper with a conclusion and an outlook (Section 6).

2 getFeedback!-Tool

Feedback is information provided by, for example, a lecturer or a peer about one's performance (Hattie and Timperley, 2007). A lecturer can provide corrective information and hint to errors, and a peer can propose an alternative approach. Empirical evidence shows that receiving adaptive, elaborate feedback is one of the most powerful factors in promoting the acquisition of knowledge and skills (Wisniewski et al., 2020; Hattie and Zierer, 2018). On the one hand, digital media can support feedback from lecturers, tutors and peers. On the other hand, feedback can be generated automatically based on machine learning algorithms (KodiLL, 2024; Kasneci et al., 2023). Findings from teaching-learning research indicate the potential of problem-based learning environments (Walker and Leary, 2009), especially when combined with feedback (Stark et al., 2011).

The getFeedback!-Tool has been developed as part of an ongoing research project (KodiLL, 2024). The goal is to support students in the acquisition of professional competences. Therefore, digital problem-based teaching-learning scenarios and tools are being developed. The

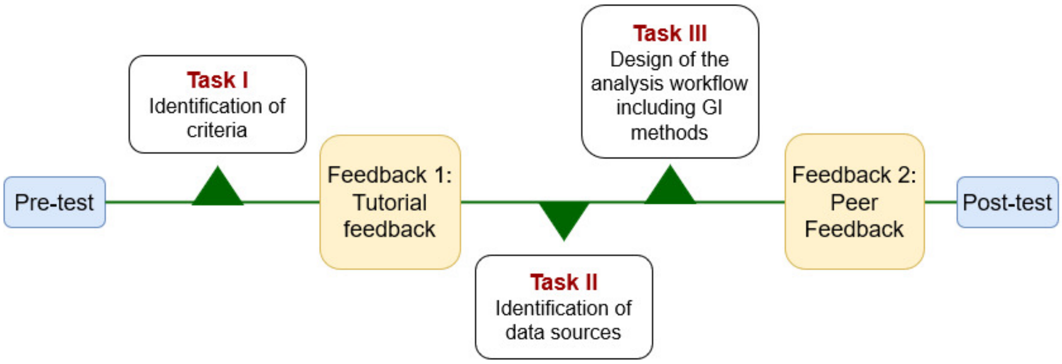

Figure 1. Case Study.

Table 1. Result of Task I: Identified criteria.

Criteria	Geodata	Datamodell
Proximity to tourist attractions	Location of swimming pools, museums, leisure park, etc.	Vector (Points)
Quiet location	Location of major roads with traffic	Vector (Lines)
Possible capacity of the pitch	Possible areas and area calculation in attribute table	Vector (Polygons)
Possible connection to tourist attractions	Location of smaller roads to reach attractions	Vector (Lines)
Proximity to good gastronomy	Location of restaurants, bars, cafes, etc.	Vector (Points)
Proximity to shopping facilities	Location of grocery stores, pharmacies, etc.	Vector (Points)
Connection to public transport	Locations of tram, bus, and train stops	Vector (Points)
Areas with a slope of <= 3 degrees	Digital terrain model (DTM)	Raster
Areas outside of nature reserve and drinking water protection zones	Location of protected areas	Vector (Polygons)

getFeedback!-Tool is implemented as a plugin in digicampus that is an interactive learning platform for the students to organise their studies. getFeedback! enables lecturers to plan and implement didactically meaningful feedback processes in lectures, exercises, or seminars. Two versions can be implemented:

1. Tutorial feedback (students receive feedback from lecturers or tutors) or
2. Peer feedback (students give feedback to each other).

Based on the structure of (peer) feedback and potential support options (Kollar and Fischer, 2010) both types of feedback have four phases: configuration, initial processing, feedback phase, and feedback reception. The feedback phase is supported by the use of prompts, i.e. hints that help to prepare the feedback. Prompts are defined by the lecturer during the configuration phase. There are several types of prompts: display prompts, input prompts, drop-down menus (editable and non-editable), points, and sliders. The lecturer can also set deadlines for the different phases within the tool. Once the configuration settings have been made, the lecturer can start the feedback process, and the students can upload their work. Then the feedback (tutorial or peer) is given and the students receive it in the feedback reception phase.

Compared to classic feedback methods, the getFeedback!-Tool with its prompts and well-structured tutorial feedback offers the possibility to give feedback to even large groups of learners, for example in a university lecture. Students giving feedback to another learner in the same course (a peer) can also increase their knowledge of the learning content and their social skills in giving feedback.

3 Case Study: Identifying a Caravan Site Location

Students could complete the course by simply completing the lectures and exercises provided. However, if they participated in the case study and successfully completed the tasks (or some of the task), they received points for the exam. The students who did not take part in the case study could compare their solutions with the sample solutions provided. They were also able to receive some form of feedback in a weekly tutorial. However, we noticed that students who participated in the tutorial also completed the case study.

The case study was divided into the following tasks: identification of criteria for the location of a caravan site, identification of data sources, and design of the analysis workflow including GI methods. After the first task we gave the students tutorial feedback (Figure 1) and after the last task they gave each other peer feedback. This section describes each part in detail.

3.1 Task I: Identification of Criteria

First, the students had to choose a district where the caravan site should be located. Then they had to collect requirements (criteria) for choosing a site. They used the "Planning guide for caravan sites in Germany" (Dieckert et al., 2018) as a help. The guide lists the following criteria: proximity to tourist attractions, quiet location, possible capacity of the pitch, possible connection to tourist attractions, proximity to good gastronomy, proximity to shopping facilities, and connection to public transport. In addition, the students were asked to consider which additional criteria were needed that were not included in the guide (e.g. slope). For each selected criterion, they were asked to explain what geodata is needed to find a suitable site. They should also indicate whether the geodata are in vector or raster format. The result of this task should be presented as in the Table 1.

3.2 Feedback 1: Tutorial Feedback

The first task was followed by a tutorial feedback. The configuration of the feedback was done by the lecturer of the course. The following prompts were defined:

1. Drop-down menu (non-editable): assessment of the required criteria;
2. Input prompt: the criterion [insert missing criterion/ criteria from list (Table 1)] should be considered;
3. Drop-down menu (editable): evaluation of additional criteria;
4. Drop-down menu (non-editable): understanding of the concept of geodata;
5. Drop-down menu (non-editable): correctness of geodata;
6. Input prompt: for the criterion [insert missing criterion/criteria from list (Table 1)] the geodata is incorrect;
7. Drop-down menu (non-editable): correctness of the datamodell;
8. Input prompt: for the criterion [insert missing criterion/criteria from list (Table 1)] the datamodell is incorrect;
9. Input prompt: space for free-text with hints "Overall, you completed the task well..."; "Take care in the future....";
10. Points: you have achieved the following number of points in Task I.

Several prompts were defined as drop-down menus. Each of these prompts had several values to choose from. For example, for prompt 1 in the list the values were: "You have identified suitable criteria for choosing a caravan site", "You have identified suitable criteria for choosing a caravan site, but you have forgotten one criterion", and "You have identified suitable criteria for choosing a caravan site, but you have forgotten some criteria". There is also an editable drop down menu (number 3 in the list above) with the values "You have selected additional suitable criteria", "Unfortunately, you have not selected any additional, suitable criteria", "You have selected additional criteria, but the criterion [insert criterion] does not apply to the choice of a caravan site location because [insert reason]" and "You have selected additional criteria, but the criteria [insert criteria] does not apply to the choice of a caravan site location because [insert reasons]". In this way the criteria and reasons can be edited and adjusted.

3.3 Task II: Identification of Data Sources

The students were asked to use the geodata portals presented in the lectures and tested in the exercises, to obtain geodata for each selected criterion. They had to download the available datasets and store them on their computer to be available for future analysis in a GeoInformationSystem (GIS). To ensure that students downloaded the data for the correct criteria, we provided a sample solution for Task I.

3.4 Task III: Design of the Analysis Workflow including GI Methods

Before starting the analyses in a GIS software, it is important to think through the logical sequence of steps required for the analyses (Task III). The students had to outline a workflow of site analysis using the required geodatasets and criteria specified in Tasks I and II (Figure 2). Note: in the sample solution for Task I we provided thresholds for area and slope but not for the distance. The students then had to explain their workflow through each step, focusing on the processing of the geodata, how this processing is done, and what results are expected after each step of the workflow.

3.5 Feedback 2: Peer Feedback

Hattie and Timperley (2007) argue that feedback on task processing is effective in mastering the task. Furthermore, feedback on the task is useful for improving self-regulation (Hattie and Timperley, 2007). We started with positive general feedback about the task, supported by a prompt with an editable drop-down menu. It included options: "In the process shown, I see all the necessary criteria in a logical sequence that will lead to the selection of a suitable area for a caravan site", "In the process shown, I see logical processing steps for most criteria that will probably lead to the selection of a suitable area for a caravan site", "In the process shown, I see logical processing steps

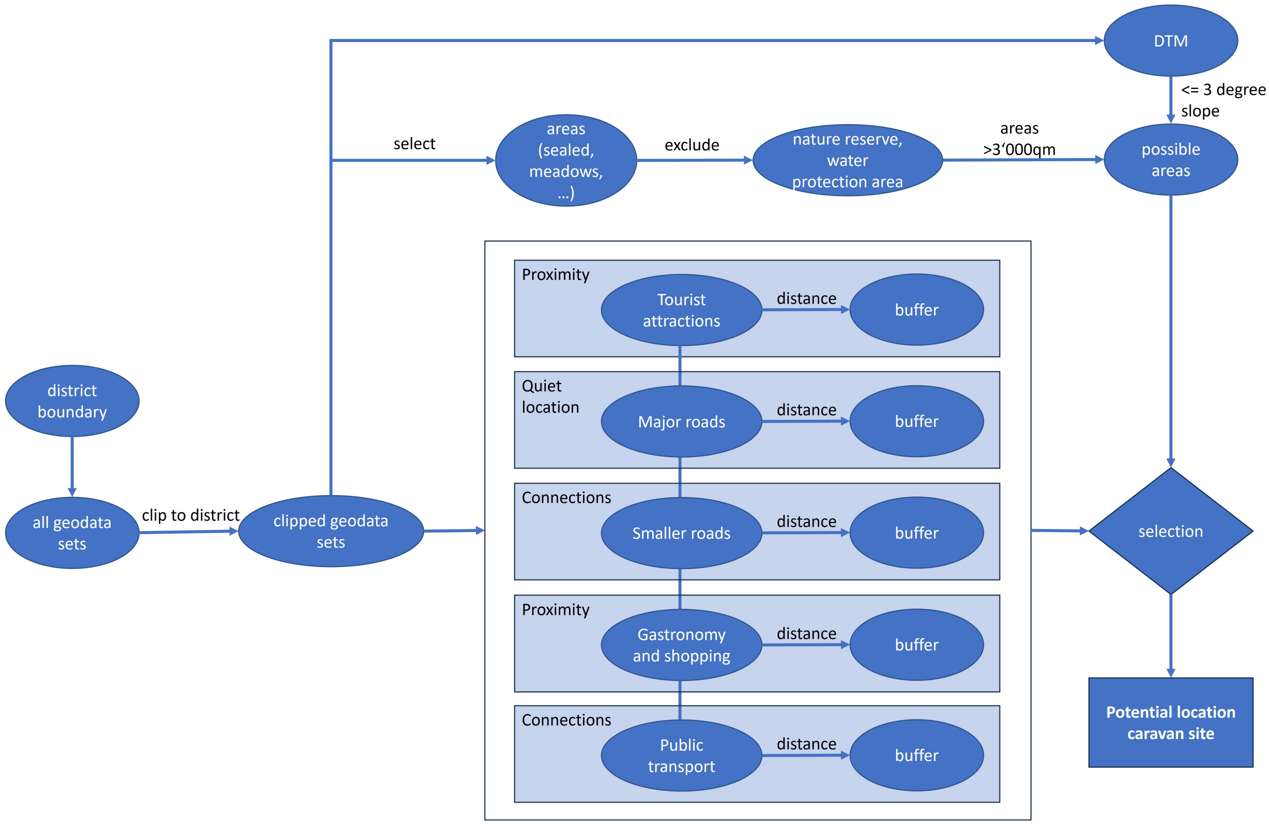

Figure 2. Result of Task III: Workflow including GI methods.

for some criteria that will allow a partial selection of suitable areas for a caravan site", and a free-text to enter own text with a positive "I" statement.

The next feedback was about the process used in the workflow. This was implemented with an input prompt that gave the instruction: "Any serious criticism must be robust. Next, two objective criteria are considered: a) Were all required criteria considered? b) Were all geodatasets used? If you feel that criteria have not been met or geodatasets have not been used, please describe this in as much detail as possible in the text box below". Constructive criticism shows what can be improved, so another prompt has been added: "The workflow should show a logical process in which input data is processed using methods/tools. The output of one step is used as input for another step. Can you see any errors or potential problems in the process? Do the methods/tools match the datasets and the desired outcome? Is the logical process complete?" The last prompt was for learning and was also implemented as an input prompt: "Good constructive criticism should not only highlight what could be improved, but also include ideas and next steps that your counterpart can take up to further develop their skills. Consider whether a different approach (including sub-steps) would be preferable and justify your statement. Can you perhaps identify a reasoning error that could cause the process to fail?" Students used these prompts to give each other feedback. They gave feedback on the workflows of two of their peers.

4 Pre- and Post-test

As part of the project, we conducted a pre-test and a post-test with the students in order to evaluate the effectiveness of the tool. We wanted to find out whether students who participated in the case study would outperform students who only did the lectures and exercises. Therefore, we asked all students who took part in the course to also take part in the tests. As the case study was voluntary, this also affected those who did not participate in the case study. The tests were carried out using the Unipark tool for online surveys (Unipark, 2023). The tests were approved by the university's data protection officer.

4.1 Pre-test

35 students took part in the pre-test (16 women and 19 males). We started with multiple-choice questions:

1. Which geodata model is best suited to describe bus stops? (vector (points), vector (lines), vector (polygons))
2. Which geodata model do you use to best describe the location of nature reserves? (vector (points), vector (lines), vector (polygons))
3. Which geodata do you need to identify areas with a slope of <= 3 degrees? (DTM, OSM, DSM)

4. From which portals can you download geodata? (geofabrik.de, lfu.bayern.de, dfg.de)

5. In vector analysis, which tool do you need to determine whether a location is close to a shopping centre? (buffer, intersect, union)

The multiple-choice questions were followed by two free-text questions:

1. For the criterion "access to public transport", explain what geodata is required to take it into account in a GIS analysis.

2. Name a geodata portal from which you can download geodata on the "location of major roads with heavy traffic".

4.2 Post-test

The same 35 participants who took part in the pre-test also took part in the post-test. The link to the post-test was sent to the students after they had completed Feedback 2. First we provided a picture of each task from Figure 1 and asked them to indicate whether they had worked on it or not. Then they had to answer the same multiple-choice and free-text questions as in the pre-test.

5 Analyses of the Results

For the analyses we consider the 35 participants who took part in the pre- and post-test. To analyse whether students who participated in the case study would outperform students who only did the lectures and exercises or only did some of the tasks, we counted how many of the tasks each of the students completed. 33 students completed Task I, identifying criteria, 32 students identified data sources (Task II), and 28 students uploaded the workflow and a description (Task III) (Table 2). 25 students provided feedback. As a first analysis, we run a regression with the number of tasks completed as the predictor and the results of the multiple-choice questions in the post-test as the outcome variable to see whether the number of tasks completed predicts the performance in the post-test. We find that the more tasks students completed, the better their performance on the multiple-choice questions in the post-test (b=0.52, p<0.01). More specifically, the number of tasks completed significantly predicts performance on the multiple-choice questions in the post-test (p<0.01) with an estimated change of 0.52 (b=0.52). The regression coefficient b indicates that if the number of tasks completed increases by one standardised unit, the multiple choice test score increases by 0.52. The same trend can be seen in the average multiple-choice-scores of the participants who completed either 0, 1, 2, 3 or 4 of the tasks (see Table 3).

However, it is possible that only students with a high prior knowledge, who are also highly motivated, would complete the case study. Therefore, potential differences between students with a high performance on the multiple-choice post-test may not have been due to knowledge gained from the case study, but rather to a high prior knowledge before the tasks even started. To account for this possibility, we run an additional second regression analysis with two predictors: prior knowledge as the first predictor of multiple-choice performance in the post-test and the number of completed tasks as the second predictor of multiple-choice performance in the post-test. To measure prior knowledge, we use the results of the multiple-choice questions in the pre-test. The result shows that the number of tasks students completed still significantly predicts the performance on the multiple-choice questions in the post-test (b=0.55, p<0.05). Therefore, the positive effect of completing the tasks remains even when we account for students' prior knowledge. However, prior knowledge, does not significantly predict the performance in the post-test (b=-0.08, p=0.62), indicating that students' prior knowledge at the time of the pre-test was not related to their knowledge at the time of the post-test. Students who answered more questions correctly in the pre-test were not necessarily those who performed better in the post-test.

For the free-text questions, we code the students' responses as either "not correct" (0), "partly correct" (1) or "correct" (2). To obtain an overall measure, we calculate the sum of the first and the second responses. The regression analyses with these measures of knowledge were identical to the regression analyses with the multiple-choice questionnaire. We find that the more tasks students completed, the higher they scored in the free-text question in the post-test (b=0.34, p<0.05). Our last analysis shows that the number of tasks students completed still significantly predicts the quality of their answer in the open questions in the post-test (b=0.33, p<0.05), even when we include the score on the free-text questions from the pre-test as another predictor in the model. However, in this case, the higher the students scored in the pre-test, the higher they also scored in post-test (b=0.44, p<0.01).

Table 2. Number of participants who completed the task or feedback.

Task/Feedback	I	Tut. FB	II	III	Peer FB
No of participants	33	–	32	28	25

Table 3. The number of tasks completed in comparison to the performance at the multiple-choice post-test (score).

No of Tasks/Feedback	0	1	2	3	4
Score	0.78	0.81	0.89	0.88	0.93

6 Conclusion and Outlook

In this paper, we present the results of a case study combined with a new tool - getFeedback!. We find that the more tasks students completed, the better they performed on the multiple-choice questions and the free-text questions in the post-test. We also find that students who answered more multiple-choice questions correctly in the pre-test were not necessarily those who performed better in the post-test. Thus, the positive effect of completing the tasks remains even when we account for students' prior knowledge. We conclude that getFeedback! combined with a case study is a valid tool to support students in the acquisition of professional competences. This finding is consistent with the finding that receiving adaptive, elaborate feedback is one of the most powerful factors in facilitating the acquisition of knowledge and skills (Wisniewski et al., 2020; Hattie and Zierer, 2018).

The scenario described here lasted for half a semester. We had 35 students who took part in the pre- and the post-test. In future studies we can repeat the study with more students to investigate the generalisation of our results. We have already implemented another feedback scenario that is currently running. In this scenario the students have to implement the identified methods (Task III) in a GIS. One part of the scenario deals with vector analysis and another part combines all the information using multi-criteria analysis (MCE), including all the raster operations. We will also carry out tests to evaluate the scenario. Once the scenario is completed, we will analyse the results to find out if this case study is also a useful tool to support students in acquiring professional competences regarding applied geoinfomatic exercises using a GIS.

7 Data and Software Availability

The materials given to the students are openly available here (in German).

The data supporting the results of analyses of the pre- and the post-test are available on request. The data is not publicly available as it contains information that could compromise the privacy of research participants.

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