New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION


We Planned Impact Research and Landed in Curriculum Reform – Meta Experiences and Insights from a Mobile Learning Project

Gottfried S. Csanyi[1]

Abstract

With "BOKU grasp", a mobile application enabling students to actually comprehend the relationships between individual variables within a formula and their influence on the final result while working in situated learning we try to contribute to the quality of scientific education at the University of Natural Resources and Life Sciences, Vienna (BOKU) [1]. After developing a first prototype we tried to evaluate its impact on student's learning.

But our approach proofed to be rather naïve. We had thought in terms of development – application – evaluation – report. Evaluation was conceived as a comparison of test group and control group with existing examination methods. Looking back we are able to recognize two major mistakes of our original concept referring to application and evaluation of our app: on the one hand BOKU grasp was not applied and could not be applied in a meaningful way. And on the other hand its influence on learning outcomes was not and could not be measured.

The details of and reasons for our partially disappointing experiences are as well presented in this paper as the guidelines for didactic interventions we began to develop as consequence of our tendencial failure.

1. Chronological reconstruction of our experiences

"After being taught to use a complex formula students are not able to interpret the results of their calculations properly and to draw the correct practical decisions from them." This is what the teachers communicated to us more or less unanimously. Therefore, we decided to develop a mobile app that relieves students of the calculation work (particularly during excursions) and thus gives them more time to reflect the results and draw conclusions from them. Our teachers appreciated this idea and were hopefully looking forward to the new technological tool that should solve one of their educational problems. But neither they nor we did fully understand the implications of the planned change in terms of indispensable prerequisites for the hoped-for success.

Step 1: The **status quo** of all co-operating course(s) is almost the same

The confrontation with the respective formulas (wood harvesting productivity, soil loss) is part of the course and traditionally taught (lecture plus two or three examples of calculations); the reflection and interpretation of results is not part of the exercises; learning outcomes referring to both, application and interpretation, are not assessed.

Step 2: Decision for innovation by introducing a mobile app

Teachers appreciate the idea to support students with mobile apps and confirm to use them in their courses. The basis of these agreements is the information, that students should use the apps on site (in the forest, on the field) for optimised learning outcomes which have to be assessed immediately (for research purposes). Teachers are commissioned to find appropriate learning arrangements for using the apps.

[1] Vienna University of Technology, Austria

Step 3: Technological and didactical **development**

Here the processes concerning both, the apps and the courses, begin to run rather different.

Mobile apps	Courses
Intensive discussions of the underlying didactic concepts and their technological implementation	Not knowing what the apps will be able to contribute teachers refrain from developing innovative concepts for their courses.

Step 4: First practical **application** of the mobile app in one course

The spontaneous trial (to integrate BOKU grasp in a course) led to a (still expected) failure.

Mobile app	Courses
The app (harvest productivity) is made for independent learning of students on the basis of practical tasks (some tasks are already included in the app)	Students are taught in the traditional way further on and asked to try out the mobile apps additionally (with an additional time requirement).

Step 5: Evaluation of the first practical application

An evaluation of the impact of the app (comparison between test group with app and control group without app) proofed to be impossible because there were neither specific learning outcomes nor any assessment at all. The underlying assumption of teachers (and the Austrian law) is "if students participate in a course they will learn something that contributes to the intended learning outcomes (even if those outcomes are not defined!)."[2] Consequently, to participate is equal with to pass.

Mobile app	Courses
The app is made to stimulate cognitive learning outcomes on level 6 (evaluation) according to Boom 1972 [2].	Students are taught for cognitive learning outcomes on level 3 (application) according to Bloom – even though teachers would like to reach level 6.

Step 6: Interpretation of results and **consequences** for the next steps

On the one hand we had the following chain of unpleasant facts: no assessment = no evaluation = no results = no interpretation. But on the other hand we had already made most of the experiences that seem to be necessary for planning a more effective approach to both, (possibly) improving the co-operating courses and getting valid research results on the impact of our apps. Some more valuable insights came forward when we discussed with teachers preparing the next round of deployment of one of our meanwhile two apps for mobile learning.

Step 7: Planning the next cycle

On the basement of our experiences from the first experimental cycle we had quite a number of meetings with several teachers to find out, which courses could fit to our apps in terms of intended learning outcomes (level 6 evaluation, or at least level 5 synthesis, according to Bloom 1972 [2]). From these discussions two new insights were derived, an organisational and a theoretical one.

Concerning the practical side it became clear that the teachers are not able to do the necessary didactic changes by themselves due to a number of reasons like lack of time, knowhow and motivation. Even though they appreciated our initiative and accepted our interventions into their courses they were not convinced enough to define new priorities. If we – the researchers – wanted to induce significant changes within the existing courses we should do all the additional work caused by these changes.

[2] Immanent examination character (Immanenter Prüfungscharakter) is defined in Austrian law and means attendance obligation on the one hand and permanent control of learning outcomes on the other hand – making an explicit assessment non-essential.

The mentioned theoretical insight confers to the art and challenge of writing examples (questions, problems, situations) for the assessment of level 6 competences: students have to link the examined knowledge to already existing knowledge in other fields. E.g. for the formula calculating soil loss (erosion by rainfall): to make a correct professional decision concerning measures for reducing erosion students might have to link their interpretation of the calculation (made by the app) to their economic knowledge or to their knowledge of work organisation. Apart from this that the knowledge of the students in other fields is often assumed but not really existing (we will come to this challenge later) the understanding of the function of and the connection between different fields of knowledge for solving a problem leads to the concepts of semantic networks and knowledge encapsulation [3].

2. Preliminary guidelines for didactic interventions

According to our experiences with mobile apps for learning some things should be clarified before beginning with experiments and research into the impact of didactic interventions (technological or didactic or organisational). To follow the guidelines below might save a lot of time and improve results of your efforts.

2.1 Verify the intended learning outcomes for the course

- **Look** what is already here: Learning outcomes are defined on rather different levels of professionality. So you have to evaluate the status quo. If you are lucky you will find what you need. At most Austrian universities the chance to be lucky is not overwhelming.
- **Develop** what is missing: If the status quo is not satisfying your needs (clear criteria and scales for measuring the impact of your intervention) you will have to work on the list of learning outcomes by yourself. But, possibly not being an expert for the respective subject matter, you can only write proposals and ask teachers to examine their factual correctness.
- **Support** teachers writing learning outcomes: On the basis of some sample proposals you can instruct your teachers to elaborate their own learning outcomes. As soon as they have understood the few principles of writing learning outcomes they will possibly like it.
- **Link** the learning outcomes of the course to other courses and the complete programme: If you want a realistic estimation of the achievability of the defined learning outcomes for your course you will have to link them to those of the whole programme and to compare them with those of the courses before and after your own one. Maybe you will find some inconsistencies and will have to rethink your learning outcomes.

2.2 Verify the actual pre-knowledge of participants

- **Analyse** available documents (course descriptions etc.): Maybe you can find some information about what is expected from participants of the particular course in terms of previous knowledge, competences and attitudes.
- **Discuss** with teachers: What you have found will have to be discussed with your co-operating teachers: what do they estimate to be realistic or not.
- **Negotiate** with teachers which knowledge can and will really be required: There should be a clear decision about the minimum requirements for the chance to participate in the course successfully. Teachers cannot always begin with zero – but they are able to compensate small lacks of knowledge and competences.

2.3 Make a new educational design for the course or the affected parts of it

- **Analyse** the status quo: The question is if intended learning outcomes and teaching methods (or learning opportunities) fit together.
- **Discuss** the results with the teachers: Communicate the results of your analysis and listen to the teacher's position. They might have different opinions.
- **Clarify** if they are satisfied with actual learning outcomes: Usually a teacher who accepted a didactic intervention in his/her course is not satisfied with what students have learnt. Elaborate together what the minimal outcomes are to be accepted.
- **Write** a new and better concept / two or three alternative proposals for a new and better concept: On the basis of the defined minimum you can propose appropriate didactical arrangements.

- **Discuss** them with the teachers: It is not likely that one of your proposals will absolutely fit to the expectations of your teachers. But there should be a chance to find ways for adoption of your proposals to the needs and capacities of your teachers.

2.4 Develop examples for learning

- **Develop** at least 10 to 15 examples (questions, problems, situations) for learning: To have a rough didactic design is one thing. To have the necessary resources for its implementation is a completely different thing. For independent learning (a necessary method for cognitive learning outcomes higher than level 1 according to Bloom) a (rather high) number of examples are the most important resource to be provided. Teachers who are not used to stimulate independent learning rarely are able to produce productive examples. So you have to step in.
- **Show and discuss** with teachers how to write appropriate examples (for stimulation of level 2+ learning outcomes): Maybe not all of the examples you have written will be correct form the subject matter viewpoint. Discussing and improving them with your teachers will motivate them to try it by themselves.
- **Let teachers write** more examples
- **Evaluate and improve** examples written by teachers: It's like giving feedback to students in cascading cycles.

2.5 Develop examples for assessment

- **Develop** at least 2 to 3 examples (questions, problems, situations) for assessment: It's the same procedure as for 2.4, but assessment examples must have the quality to assess as many aspects of the intended learning outcomes as possible. And they are the material for the evaluation of your intervention – and thus your central concern!
- **Show and discuss** with teachers how to write appropriate examples (for assessment of level 2+ learning outcomes): see above
- **Let teachers write** more assessment examples
- **Evaluate and improve** assessment examples written by teachers: see above

2.6 Develop an appropriate design for assessment

- **Analyse** status quo of assessment: The question is if the existing design of assessment fits to (newly defined) learning outcomes and your needs for research – which probably will differ from the teacher's needs.
- **Discuss** different options of assessment design with teachers: Communicate the results of your analysis and listen to the teacher's positions. They might have different opinions to yours.
- **Write** a new and better assessment design that fits to all needs as exact as possible.
- **Discuss** them with the teachers for fine tuning

If you have accomplished all these tasks you can start with your didactic intervention (e.g. introducing a mobile app for learning) at that point we took for granted without the need to be established in our responsibility.

3. Our current and next activities

At the moment we are doing what is described under 2.4 to 2.6. in terms of the universal soil loss equation (USLE), our second mobile app. One example may illustrate the work that has to be done for writing usable examples (see appendix, page 5).

The next intended step is a workshop (4 to 6 hours) for defining learning outcomes and exercises for all involved teachers (appr. 5-6) in the middle of February 2017. At the moment it is still not clear if the teachers will be ready to spend so much time for this purpose.

And during the coming summer semester (March to June 2017) both mobile apps and the respective example will be tested in appr. 5 courses (in forestry and agriculture).

References

[1] Michalek, C.R. & Csanyi, G.S. (2016): Forget the Formula, Reflect Your Results! How to Learn Complex Correlations with Mobile Apps. Proceedings of "New Perspectives in Science Education", Firenze, 17.-18.03.2016
[2] Bloom, B. S.; Engelhart, M. D.; Furst, E. J.; Hill, W. H.; Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. New York: David McKay Company.
[3] Boshuizen, H.P.A. (1999): Development of Medical Expertise: Implications for the Curriculum. ZSfHD 2/99, 30-40.

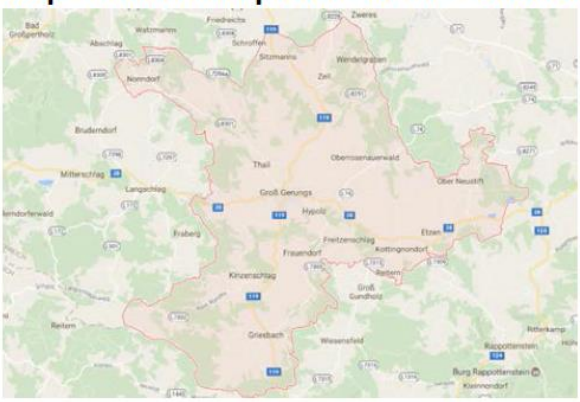
Appendix: Sample example

Exercise 2

Essence
When do support practices show any positive effects?

Title
Kirchbach, Styria

Map section and picture of the situation



Description of the situation

- R average annual precipitation = 550 mm (R = 47)
- K soil type = loamy sand, depth > 100 cm
- L slope length = 120 m
- S slope gradient = 5 %
- C crop rotation and management = corn open soil

Tasks

1. What is the annual soil loss when no erosion protection is applied?
2. What is the annual soil loss when contouring is applied?
3. What is the annual soil erosion in the case of contour stripcropping (strip width = 30 m)?
4. What would be the optimal combination of measures (cover and management as well as support practice) for the protection against erosion under the given conditions?