Evaluation of Student Teachers' Perceived Quantitative Workload and Usefulness of an On-line Elementary Science Education Course Unit

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Abstract

We have designed a 1 ECTS on-line science pedagogy unit as a part of a 6 ECTS science education course for elementary school student teachers. To improve the unit, we asked 169 participants to estimate their use of time and the usefulness of the themes and contents in it. We analysed the responses in the framework of students' perceived workload. The Basics of School Science was perceived as the most useful section, followed by Science Teaching and Learning Methods and Basics of Science and Scientific Knowledge in Schools, respectively. This in mind, we discuss the rescaling of the workload and the respective weights student perception and teacher expertise should have in the process.

Key words

Perceived quantitative workload; perceived usefulness; on-line science pedagogy course unit

INTRODUCTION

Curricula need to be reformed or reviewed every now and then, in order to respond to the dynamic visions and changes in the intended outcomes, learning environments and pedagogy. The curriculum of our Department of Teacher Education at the University of Jyväskylä in Finland was last reformed two years ago. In this reform, the resource of the courses of pedagogy of natural and environmental sciences decreased from 8 to 6 credits of the European Credit and Transfer and Accumulation System (ECTS). This loss, but also the changes in the operational environment due to the multiple global and local incidents, required us to enhance and intensify our digital services in education. We designed a new course of Environmental and Science Education and split it into three units: Active learning in small groups, Text-book exam and On-line science pedagogy studies (On-line unit) (3, 2 and 1 ECTS, respectively). In this report we describe the student teachers' perceived subjective workload and compare it with their perceived usefulness of the themes and the materials in the On-line unit. This case study is a part of design-based research (DBR) to further develop the whole designed course.

In the On-line unit, we ended up with 15 themes, which can be seen in Table 1. The teaching and learning materials were designed by 6 experts in our team. Each of the experts designed materials for 1-5 themes, according to their own specialty. The unit was implemented on-line in Moodle learning

management system. The learning materials of the themes varied between texts, videos and interactive contents. Most of the tasks were automated multiple choice control questions, with exceptions of one productive task of curriculum analyses and two discussion boards for the themes of differentiating and science in society.

Theoretical Framework

Workload has been recognised as the major factor in a teaching and learning environment that influences the quality of learning (Kyndt et al., 2011). The European commission defines ECTS credits as the volume of learning. One credit corresponds to 25 to 30 hours of student's work. However, this is just an overall estimation of the objective time that learners may need to complete the activities to achieve the curricular learning outcomes. It is obvious that having too little time to study does not lead to good learning. On the other hand, linear increase of the ratio of working hours to learning objectives does not continuously improve the quality of learning and teaching. As Karjalainen et al. (2006, p. 13) formulated: "Even an infinite amount of time does not guarantee learning, although the existence of time is an essential condition to learning, it is not sufficient itself, other factors are needed as well".

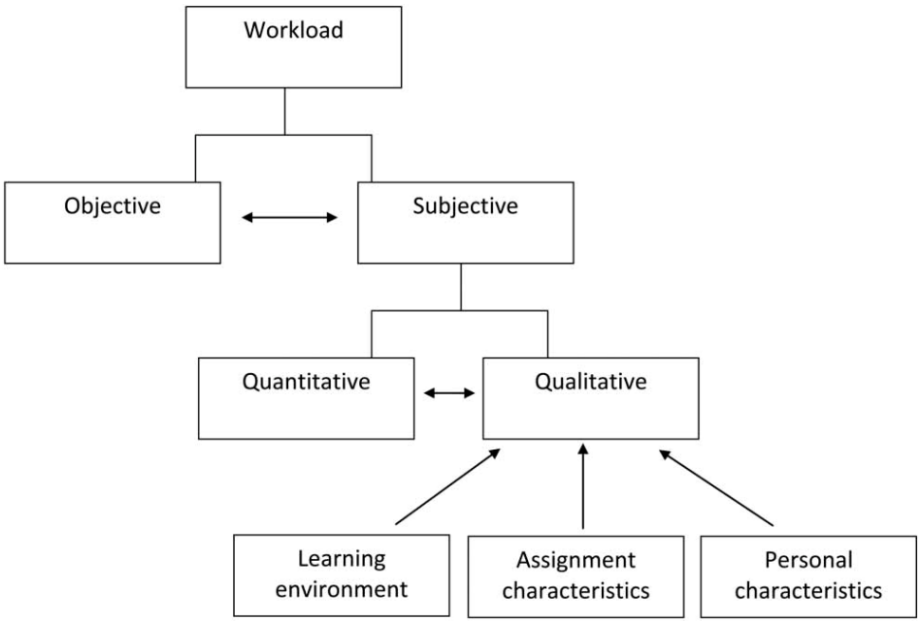

Fig. 1 The conceptual framework by Kyndt (2014), and Kemper and Leung (2006) for objective and quantitative and qualitative subjective workloads was used in this study.

These other factors comprise students' subjective, or perceived, workload (see Figure 1). Kember and Leung (1998) found that the objective workload explained only 4% of the variance of students' perceived workload. Research has shown that high perceived workload leads to a surface type of learning (Entwistle and Ramsden, 1983; Kember et al., 1996; Kember and Leung, 1998 and Beaten et al. 2010). High demands may or may not correlate with that, depending on the teacher (Kemper

& Leung, 2006). Also, the teaching and learning environments are only weakly related to perceived workload. However, Kemper and Leung (2006) described a teaching and learning environment that can be organized to produce good quality learning while perceived workload is still considered reasonable, minimizing the extraneous workload (Sweller et al., 2011). All the above suggests strongly to study students' perceived workload to optimize course designs, learning environments and outcomes for deep and effective learning.

Kyndt et al. (2014) formulated ideas of Kemper and Leung (2006) into a conceptual framework of students' workload. Figure 1 outlines, how subjective, or perceived, workload can further be divided into quantitative and qualitative workloads. Quantitative perceived workload differs from the objective workload, being the student's effective time used for learning (Marsh, 2001). The components of qualitative workload covers the course design and student's personal characteristics. The course design has an effect on the students' perceived qualitative workload via pedagogy and curriculum. Lectures are seen as ineffective teaching (Kember, 2004). Active learning, such as project-based education and real-life contexts are seen as effective and motivating, integrating theory and practice by means of problem-solving related to working life issues (Blumenfeld et al., 1991). Both the content and difficulty of the assignments influence the perception of workload (Kember, 2004). The content of an assignment is defined by its theme and materials. The personal characteristic has a self-strenghtening feedback between learning and interest and vice versa (Karjalainen, 2006). The students' views about the usefulness of the studies can be considered as a factor in this positive feed-back loop. We have not seen any earlier reports comparing student teachers' perceived workload with their perceived usefulness of different themes and materials of science pedagogy.

To study the student teachers' perceived workload in the designed 1 ECTS on-line unit within our Environmental and Science Education course, we first wanted to know if the essential precondition of 25 to 30 hours time being enough time to complete the unit is fulfilled. After that, we mapped the qualitative workload of the unit under the measure of the student teachers' perceived usefulness of the themes of the unit as well as the contents of study materials and tasks for learning them. For this, we set a research question: How do student teachers perceive their quantitative workload and the usefulness of the different themes of the elementary science education on-line unit?

METHOD

A questionnaire was designed to survey student teachers' perceived quantitative workload in studying each of the 15 themes and the usefulness of the materials and tasks designed for learning them. The perceived time used for studying the materials and the tasks were estimated as the time slots of < 30

min., 30-60 min., 60-90 min., 90-120 min., >120 min. for studying materials and <15 min., 15-30 min., 30-45 min., 45-60 min., >60 min., for tasks. The perceived usefulness was evaluated by 5 step Likert ordinal scale with categories from *not useful (1)* to *extremely useful (5)*. In addition, the questionnaire requested open feedback or other ideas considering the content, material and task of the theme in question. The questionnaire was embedded into the tasks of each 15 themes.

The data was collected during the pilot of the On-line unit, with 169 elementary student teachers mostly in the second year of their academic studies, in the period of autumn 2020 - spring 2021. Answering was voluntary and took place after the completion of the tasks of each theme.

RESULTS

The first column in the Table 1 shows the themes of the unit. Student teachers assessed their use of time for studying by the materials and carrying out the tasks in each of these themes. The median intervals of the assessments are listed in the following columns respectively.

Tab. 1 Medians of the time intervals used for the learning by the materials and the tasks assessed by the student teachers. The themes were designed under 3 sections, 5 themes in each: Basics of School Science (red), Basics of Science and Scientific Knowledge in Schools (green) and Science Teaching and Learning Methods (blue). The performances perceived as extremely quick are highlighted with bold typeface.

Themes	Materials	Tasks
1. Curriculum design	30-60 min.	30-45 min.
2. Objectives, methods and assessment	30-60 min.	15-30 min.
3. Classroom interaction	**<30 min.**	**<15 min.**
4. Differentiation and learning difficulties in science education	30-60 min.	15-30 min.
5. Working safely and safety education	**<30 min.**	**<15 min.**
6. Nature of science	30-60 min.	15-30 min.
7. Science in society	30-60 min.	15-30 min.
8. Concepts, conceptual structures and conceptions	**<30 min.**	15-30 min.
9. Knowledge structures of experts and novices, knowledge organization in teaching and learning	**<30 min.**	**<15 min.**
10. Developing thinking skills in science teaching	30-60 min.	15-30 min.
11. Phenomenon based learning	30-60 min.	15-30 min.
12. Project based education	30-60 min.	**<15 min**
13. Simulations in environmental and science education	**<30 min.**	**<15 min.**
14. Games and gamification in environmental and science education	**<30 min.**	**<15 min.**
15. Tips for herbarium	30-60 min.	15-30 min.

The student teachers perceived the usefulness of the different sections of themes differently. On average, the student teachers considered the first section *Basics of School Science* and its theme of *Differentiation and learning difficulties in science education* (Differentiating) very useful (the median value). This theme was followed by the themes of *Working safely and safety education* (Safety); *Objectives, methods and assessment* and *Curriculum design*. The *Science Teaching and Learning*

Methods section and the theme *Project-based education* (PBE) within, the student teacher audience perceived also as very useful (median value). The least, but still moderately, useful ranked themes were *Knowledge structures of experts and novices*, *knowledge organization in teaching and learning* (Novice-Expert), and *Developing thinking skills* in science teaching in the section of *Basics of Science and Scientific Knowledge in Schools*. This trend of the perceived usefulness by student teachers can be noticed in Figure 2., where the distributions have been plotted combining their assessments in the categories of "Not useful and Somehow useful" (1 and 2 in the Likert scale), "Moderate useful" (3) and "Very useful and Extremely useful" (4 and 5).

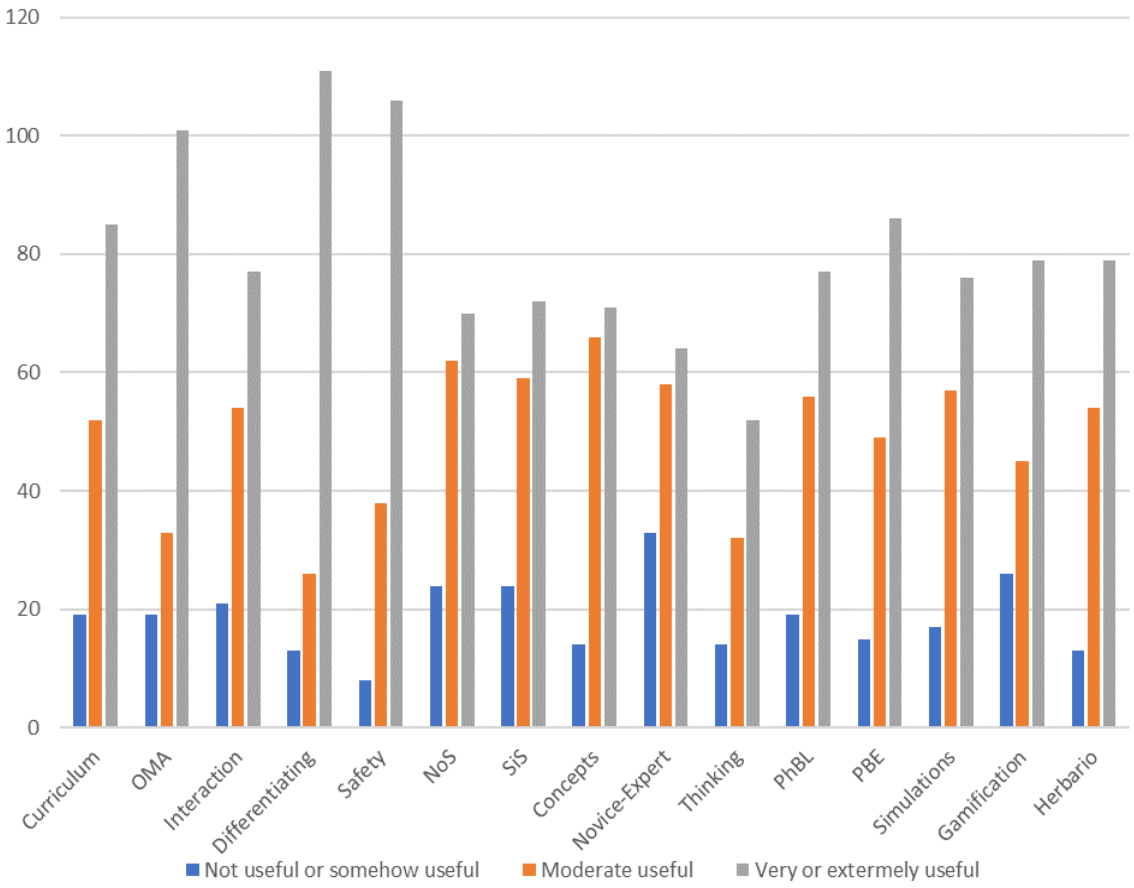

Fig. 2 Student teachers' perceived usefulness of the themes of the unit.

A similar trend and the median values apply with the perceived usefulness of the teaching and learning materials in Figure 3. The study materials of exactly the same themes were perceived most useful as the themes themselves in the section of *Basics of School Science*. In the section of *Science Teaching and Learning Methods*, the study materials of Simulations in environmental and science education (Simulations) and Herbarium exceeded the usefulness of that for the theme PBE. The study material of Developing thinking skills in science teaching in the section of *Basics of Science Pedagogy* was perceived the least useful by the student teachers.

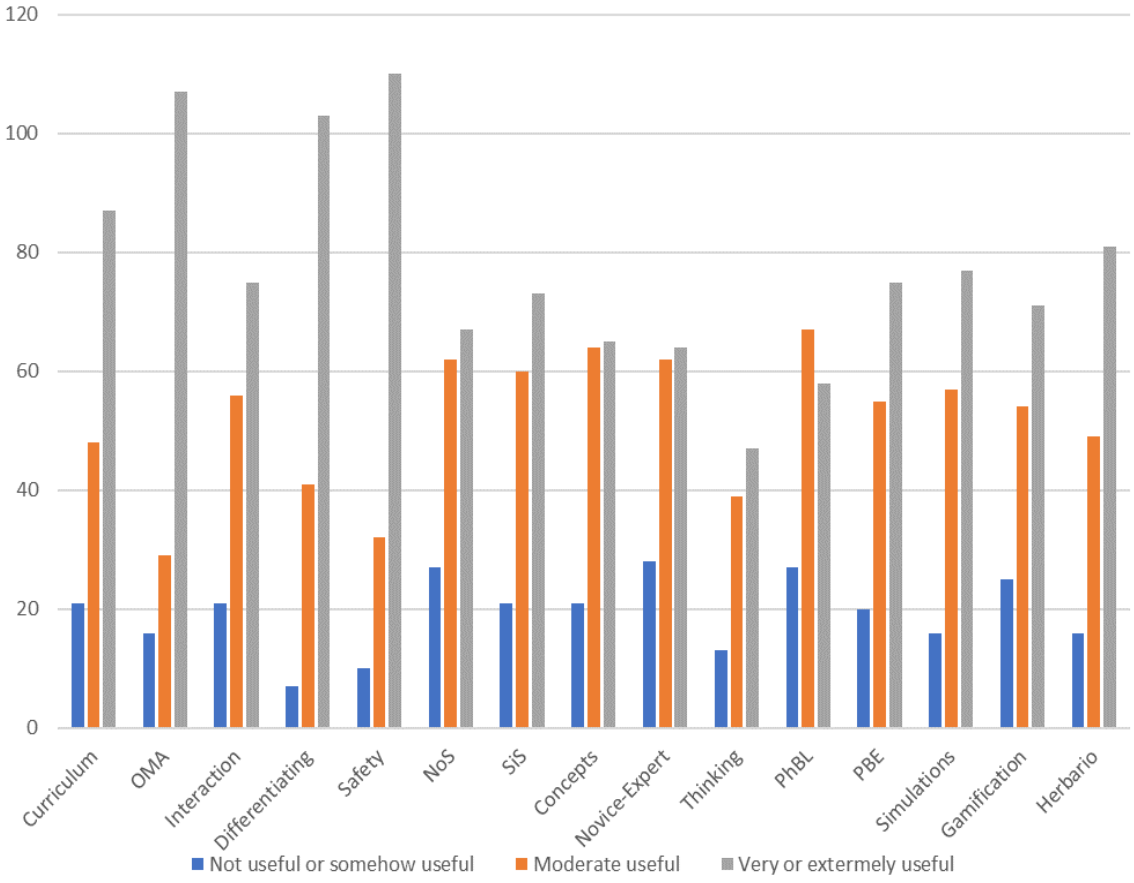

Fig. 3 Student teachers' perceived usefulness of the study materials prepared for each of the themes of the unit.

CONCLUSIONS

As the sufficient time to study is an essential condition to learning, (Karjalainen et al., 2006), the students' perceived quantitative workload should not exceed the intended workload. In this 1 ECTS on-line unit of Environmental and science education, the median categories of the student teachers' perceived quantitative workload of each of the 15 themes settled on 30-60 minutes for studying the materials and 15-30 minutes for accomplishing the tasks. As the 1 ECTS means 25 to 30 hours of objective qualitative work for students, these perceptions of quantitative workload seem equitable and the design of the themes of the units reasonable. The highest median for the perceived workload of the tasks was the theme curriculum design i.e. production of a table comparing the competences of a selected topics across the curricula of school grades (30-45 minutes). This may be considered as the upper limit of quantitative workload of one theme. Increasing the workload of a theme bigger than this this should be well-grounded and reasonable to the teacher students. The other end of the quantitative perceived workload was in the themes of Classroom interaction, Safety, Novice -experts, Simulations and Games and gamification in Environmental and science education (median categories

of <30 and <15 minutes each). The objective quantitative workload of these kind of themes may be considered to be increased, if needed.

Student teachers' perceived usefulness of themes and their study materials may be connected to the measures of contents and assignment of the course design in the construct of quantitative perceived workload (Kemper & Leung, 2006). Both the themes and the study materials of *Basics of Science and Scientific knowledge in Schools* were perceived the least useful by the student teachers, which may increase their perceived workload in this section. However, it should be kept in mind that the student teachers' perceived usefulness of the themes and materials serves only as an indicator of their subjective quantitative workload. It does not tell anything about objective usefulness of the themes of the materials. It is the teachers' and course designers' professionality, which defines the implementation of both the contents and methods of curricula. However, the less useful the students perceive a theme, the more activating methods (Kemper, 2004) and materials with smaller workload need to be considered in teaching them to ensure greater part of the working memory capacity to issues germaine to learning (Sweller et al., 2011). In our pilot version of this On-line unit of the new course of Environmental and Science Education, our intent is to teach such themes in the Active learning in small groups -unit of the course.

The next step in our design-based research of developing the On-line unit and the whole course of Environmental and science pedagogy is analysing the student teachers' open responses in the questionnaire. Those will be analysed along with the results reported here together with the designers of each of the themes in the unit. The contents under the themes will be modified, if needed, to take into account the student teachers' perceived qualitative workload, the perceived usefulness of the theme and the study materials, the open responses, and the ideas from the designers and the teachers of the course. To restrain the perceived workload with recommendations of a coherent programme of courses or subjects with a transparent relationship between them (Kemper, 2004), also the instructors of the course will be asked about the connections between the different units of the course.

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LITERATURE

Beaten, M., Kyndt, E., Struyven, K., & Dochy, F. (2010). Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review*, *5*(3), 243–260. https://doi.org/10.1016/j.edurev.2010.06.001

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, *26*(3-4), 369-398. https://doi.org/10.1080/00461520.1991.9653139

Entwistle, N.J., & Ramsden, P. (1983). *Understanding student learning*. Croom.

Karjalainen, A., Alha, K., & Jutila, S. (2006). *Give me time to think. Determining student workload in higher education*. Oulu University Press.

Kember, D., Ng, S., Pomfret, M., Tse, H. & Wong, E. T. T. (1996). An examination of the interrelationships between workload, study time, learning approaches and academic outcomes. *Studies in Higher Education*, *21*(3), 347–358. https://doi.org/10.1080/03075079612331381261

Kember, D., & Leung, D. (1998). Influences upon students' perceptions of workload. *Educational Psychology*, 18(3), 293–307. https://doi.org/10.1080/0144341980180303

Kember, D. (2004). Interpreting student workload and the factors which shape students' perceptions of their workload. *Studies in Higher Education*, *29*(2), 165–184. https://doi.org/10.1080/0307507042000190778

Kember, D., & Leung, D. (2006). Characterising a teaching and learning environment conducive to making demands on students while not making their workload excessive. *Studies in Higher Education*, *23*(2), 185–198. https://doi.org/10.1080/03075070600572074

Kyndt, E., Dochy, F., Struyven, K., & Cascallar, E. (2011). The perception of workload and task complexity and its influence on students' approaches to learning: A study in higher education. *European Journal of Psychology of Education*, *26*(3), 393–315. https://www.jstor.org/stable/23883591

Marsh, H.W. (2001). Distinguishing between good (useful) and bad workloads on students' evaluations of teaching. *American Educational Research Journal*, *38*(1), 183–212. https://doi.org/10.3102/00028312038001183

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. Springer.

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