Task quality vs. task quantity. A dialog-based review system to ensure a certain quality of tasks the MathCityMap web community

Simone Jablonski[1], Matthias Ludwig[1] and Joerg Zender[1]

[1]Goethe University Frankfurt am Main, Institute of Mathematics and Computer Science, Germany, jablonski@math.uni-frankfurt.de

Authentic tasks require realistic objects and questions, which can for example be realized through outdoor mathematics. MathCityMap takes up this idea of outdoor mathematics through the creation of math trails, which lead to places where interesting mathematical problems can be observed and solved. MathCityMap bases on an app and a web portal in which every registered user is allowed to create and publish own tasks. Through a constantly growing community and the claim of a certain quality of the published material, the system bases on a multistep review process and several criteria for published tasks. The paper presents the steps of the review process, defines the underlying criteria and how they are communicated, and discusses the consequences of a review system for users and their professional development.

Keywords: modelling, task design, stepped hints, feedback, mobile devices.

INTRODUCTION

Especially through integrating realistic tasks in mathematics school lessons, modelling and authentic tasks play an important role in this context (e.g. Borromeo Ferri, Greefrath & Kaiser, 2013). Modelling means – apart from other processes – to translate real and authentic contexts into mathematical models and vice versa. Following the definition of Vos (2015), the authenticity of a task is given if (1) the task is created in an "out-of-school" origin and (2) the task has a "certification" (p. 108). Nevertheless, these types of tasks are often proceeded inside the classroom with help of a picture and/or text information. This means that a mathematical problem referring to an authentic object is in many cases adapted to the educational context. Here, the authenticity in the sense of a certification is obviously not guaranteed.

Taking up this issue, one can observe a trend in doing outdoor mathematics through running so called math trails. The idea of math trails, meaning a route which leads to special locations where mathematics can be observed, is already some decades old. In the 1980s, the first documented math trails were created in Melbourne, Australia by Blane and Clarke (Blane & Clarke, 1984). Nevertheless, the original intention was not to teach mathematics or modelling competence in the educational context, but to popularize mathematics in society. In 2012, the MathCityMap (MCM) project was funded at Goethe University in Frankfurt, Germany and led the idea of math trails into the educational context with help of new technologies (Ludwig, Jesberg & Weiß, 2013). In the following, we will present the project and focus on the basic review system, which is an important feature of the project in terms of quality aspects and the professional development of teachers as task designers.

THEORETICAL FRAMEWORK

Review Processes

Reviewing process is a common way to guarantee quality in science, literature or music. Even commercial reviews, often based on user opinions, are getting more helpful when mixed with expert reviews (Connors, Mudambi, & Schuff, 2011). In academia, peer or expert review is standard. It "is the process by which experts in some discipline comment on the quality of the works of others in that discipline." (Price & Flach, 2017, p. 70). It is a common way of guaranteeing quality of academic papers and material produced by different authors (Price & Flach, 2017). Also in growing web communities, which allow users to produce and publish material, re-viewing processes are necessary.

Wikipedia is an example of an online platform with over 40 million articles that anyone can edit (Brandes & Lerner, 2007). This amount of articles and authors does not allow for a review of every edit and asks for a complex review process. Review and protection elements used by Wikipedia are the storage of elder pages in case of edits, and the distribution of roles, e.g. reviewer or administrator, which allow particular actions on Wikipedia (Ferschke, 2014). This enables experienced users to give feedback on the edits of "normal" users in so-called flagged revisions (Ferschke, 2014). Further, "[t]he editorial review was intended to minimize the risk of vandalism and improve the accuracy and overall quality of the articles by having experienced Wikipedia authors approve revisions before they go public." (ibid., p. 33).

GeoGebraTube, a platform with online material for the dynamic mathematics soft-ware GeoGebra, serves as an example of reviewing material in the context of math-ematics education. The tool makes it possible to create and access material e.g. worksheets, for the software. Currently, about one million files are available. In terms of quality, GeoGebraTube counts on editorial review, which rates excellent materials, and on user review (Gassner & Hohenwarter, 2012).

These two examples show the conflict of providing quality and quantity in a growing content creating web community. Especially in the educational context, openness in terms of the creation of material has to consider "limitations in the verification of learning outcomes" (Camilleri, Ehlers & Pawlowski, 2014, p. 39).

We take up this issue and bring it into the context of the MathCityMap (MCM) project, which asks for a review system for mathematical tasks. The problem of quality and quantity leads to the following research question: Which impact does the MathCityMap review system have on the quantity and quality of published tasks?

To answer this question, we present the MCM project and its review process on a theoretical basis. Afterwards, the analysis of a successfully reviewed task will bring first results on the research question and a basis for further studies.

IMPLEMENTATION

The MathCityMap project

The MCM project is a digital tool to facilitate the integration of math trails in the educational context. Through GPS-coordinates on a math trail map, it leads to places where interesting mathematical problems can be found and solved (Ludwig et al., 2013). The map and trail data are available in the MCM app, which navigates to these spots, gives direct feedback on entered solutions, and offers hints. In the MCM web portal (www.mathcitymap.eu), one can access published MCM tasks and trails, spotted in many different countries all over the world (Figure 1).

Task: Table Mountain's Monument (Cape Town, South Africa)

Definition of the task: Calculate the mass of the stone monument. Give the result in kg. 1 cm³ of granite weighs 2,6 g.

Figure 1: MCM Task on Table Mountain's Monument

The web portal also enables to create one's own tasks and trails. These tasks can either be used for own purpose, or can be published and shared with all registered MCM users. Although the MCM project benefits from a growing community and a growing number of material, the published tasks have to meet the MCM standards. To guarantee this, all tasks have to go through a review process before publishing.

The MathCityMap review process

The MCM review process, established in Oct 2016 for published tasks, is based on four steps (see Figure 2).

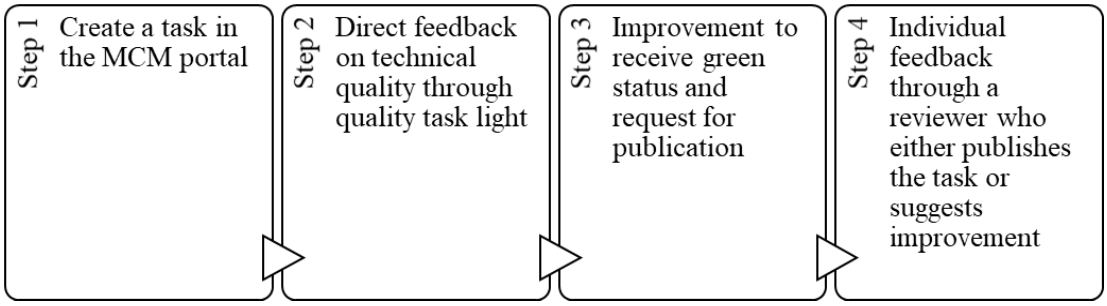

Figure 2: The MCM review process in four steps

Step 1: The registered author creates a task in the MCM portal.

Step 2: A task light gives direct feedback (red, yellow and green) on the completeness and fulfillment of technical criteria. In the example in Figure 3, a task fulfils all "orange" technical criteria, and all but one "green" criterion. The task cannot be submitted into the review process without improvement. Since many review processes solely included technical issues, to draw attention on didactical feedback, traffic light system was included, which is helpful and timesaving for users and reviewers.

Step 3: In case all criteria of the green level are fulfilled, it is possible to submit the task into the review process.

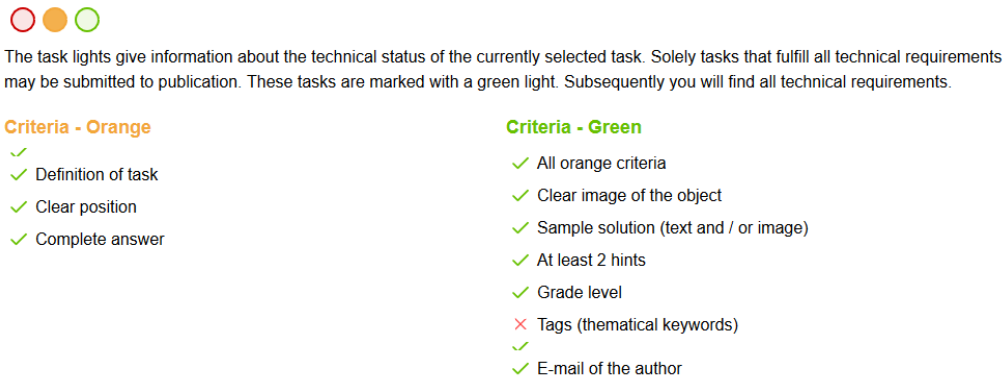

Figure 3: Example of a feedback given by the task light system

Step 4: In the review process, the task is checked in terms of the appropriateness for a published MCM task. This is done for each language by selected experts with experience in the creation of MCM tasks and running of MCM trails. After the review, the task is either published in the portal, or the author receives feedback on how to revise the task via e-mail. All review feedback for a task is stored in its review log.

This process guarantees that only appropriate tasks that correspond with the math trail idea and the MCM concept are published and shared with the community. The MCM web portal consists of 2289 tasks (Feb 2018), out of which. 956 are public (42%), wherefrom the newest 651 (68%) went through the described review process.

Nevertheless, through a growing community and number of authors and reviewers, the system asks for a transparent review guideline in order to avoid arbitrariness.

Criteria for tasks in a MathCityMap math trail

A catalogue of criteria was developed, based on relevant literature and years of experience enabling authors to comprehend feedback and reviewers to give a transparent feedback on submitted tasks.

1. *Uniqueness*. To make clear which object is meant, every task should provide a picture that helps identify the object of the task and what the task is about.
2. *Attendance*. A task should be authentic, i.e., leaving the educational context and having a certification. Thus, the task can only be solved at the object location and its description should never be enough to solve it (Ludwig et al., 2013).
3. *Activity*. Physical activity has a positive effect on learning, implying the idea of embodied mathematics, i.e., mathematics can only be fully comprehended through an active experience (Tall, 2013). The task solver should therefore become active and do something in order to solve the task, e.g. measure and count.
4. *Multiple solutions*. Authentic and modelling tasks are characterized by the fact that they are solvable in different ways through the choice of a mathematical model. The task should therefore be solvable in various ways.
5. *Reality*. An important characteristic in this context is the connection of mathematics and emotions, interest and relevance for the students – aspects that

significantly correlate with performance (e.g. Tulis, 2010). The task should have meaningful relevance and not appear too artificial.

6. *Hints*. As Jesberg & Ludwig (2012) summarize, several studies come to the conclusion that stepped aids have a positive impact on learning performance, experience and communication (Jesberg & Ludwig, 2012). Therefore, every task should provide at least one hint in terms of solving the task.
7. *School math and tags*. The task should feature a connection to school math. Therefore, one can use tags with relevant key words and assign them to a grade.
8. *Solution formats*. The solution should be representable in one of the solution formats provided by MCM: interval, exact value and multiple choice.. Especially for modelling tasks, the interval seems very relevant as it enables to refrain from minor deviations in the solution, as through measuring differences or different mathematical models. In this format, one defines a green interval for correct solutions, and an orange interval for incorrect, but acceptable ones. Solution values that do not fit into these intervals receive the negative feedback and the player tis asked to retry.
9. *Tools*. The task should be solved without special and extraordinary tools apart from calculator, measuring tape etc.
10. *Sample solution*. One should provide a sample solution including measured data (only visible in the portal and in the solution PDF) for teachers in order to talk about the tasks in the following lessons and analyze typical errors.

The catalogue is formulated for single tasks as they are individually checked within the review process. Nevertheless, a math trail idea is a combination of different tasks that should harmonize as a trail. Therefore, the whole trail comes into the review process after every task of a trail went through it.

Communication

Apart from defining a catalogue of criteria, it obviously has to be communicated to active and future authors. One way is to present the criteria for MCM tasks during teacher training before the teachers create their own first tasks. On the MCM website, one can find a tutorial explaining MCM tasks criteria and best practice examples in the newsfeed category “Task of the Week” where already published tasks are analyzed in terms of the MCM criteria. A further step towards facilitation and transparency in the reviewing process is the idea of generic tasks. Common objects, such as stairs, offer the chance to easily and quickly transfer existing tasks to other locations.

An important part in the communication of criteria is the individual feedback within the MCM review process. Figure 4 shows an example of a task which passed through this process. First, the task was created in the web portal and reached green status in the task light system according to its technical quality. After the request for publication, the author received a feedback on the fulfillment of the MCM criteria. Through the picture, it fulfilled criterion 1. The measurements which have to be done on the object guarantee criteria 2 and 3. The area of the hexagon can be determined in multiple ways (criterion 4). Green light in the traffic light system guarantees that hints, school math

and tags, as well as a sample solution (criteria 6, 7 and 10) are fulfilled. The task does not require special tools (criterion 9). Some information on the height of the bottom plate of the flowerpot had to be included (criterion 5 “Reality”). The answer type exact value initially defined was not adequate for measuring tasks as it does not allow multiple solutions and minor measuring deviations. Thus, the task needed further improvement (criterion 8 “Solution format”). After receiving feedback, the author was able to improve the task and can request for publication again.

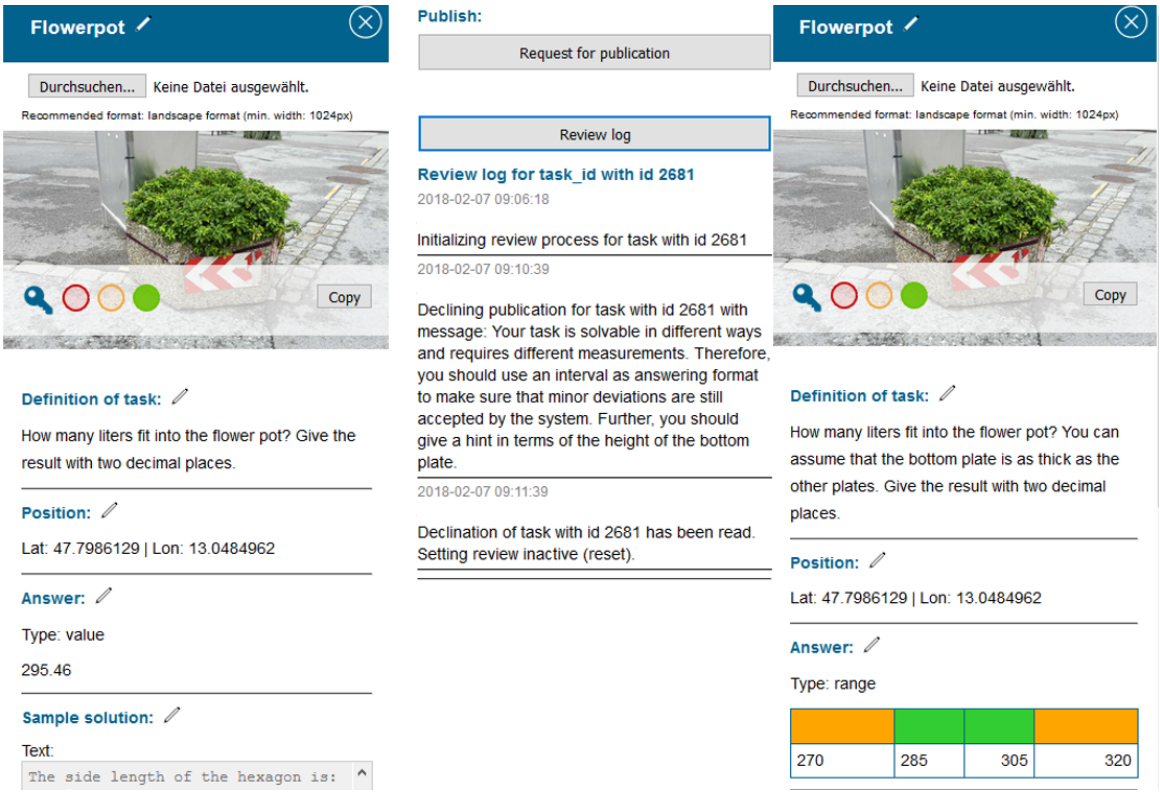

Figure 4: Example of a review process in the MCM web portal

Especially in regard of measuring tasks and solution formats, we can often observe problems with the definition of an adequate, didactical reflected interval. For example, a task asks for the determination of the weight of gravel which is needed to fill a circular area. The author created the task in respect of all criteria, even with an interval as solution format. Nevertheless, in the review process, the task expert did some errors in calculations with marginal measuring differences. He came to the conclusion that the interval might be too to let the students use different methods and to accept minor measuring errors. Therefore, he rejected the task with the hint to improve the interval. The author improved the task and afterwards it could be published. Thanks to the feedback of the task author, we can see in a qualitative way that this kind of feedback helped the teacher improve the task in terms of an authentic outdoor task:

> Thank you! For publishing the task and especially for the hints and corrections. […] Especially helpful was the hint in terms of the interval areas for the circular area […] (quoted from an e-mail; translated into English).

Apart from the benefits of a review system, users and reviewers face several consequences. As the statistics show, more than a half of all created tasks have not been published. We see two possible reasons. First, not all task creators want to publish or see a benefit in publishing and sharing own material. They regard MCM as a tool that they use for their individual needs. Second, the review process may hinder authors to revise their task after it was rejected. Even though our statistics and experience show that some authors are willing to revise their tasks up to three times and are thankful for the received feedback, we observe that 130 out of 743 review processes (17,5%) were interrupted after feedback was given. This observation is a small limitation of the MCM web portal in terms of public quantity, which can be accepted in advantage of the increased quality of published tasks. Nevertheless, the review system is a developing process to be optimized with the users' feedback and needs.

The whole process is a new situation for teachers through a definition of new roles. The teacher is not only the task user in this process, but also the task designer who asks for feedback. Through our dialogue-based review system, a potential contribution towards professional development can be realized (Jones & Pepin, 2016).

DISCUSSION

The paper gives an overview of the educational web portal of MCM, in which a growing community participates in creating and sharing material. For this purpose and in terms of the idea of authentic math trail tasks, a certain quality of the material must be guaranteed before it can be published. In this context, a review process is introduced and presented in terms of steps and fundamental criteria that allow transparency. The implementation shows that the review system can prove itself not only theoretically. Through an adequate and transparent communication of the underlying steps and criteria, users are willing to improve their tasks according to the standards. Especially for the "Solution Formats" criterion, we observe major improvements leading to adequate outdoor tasks. We also observe that less than every fifth task review does not end in a published task. The MCM review process is thus a successful example of quality standards in a digital educational community platform. However, such a system faces consequences, mostly in terms of quantity of tasks and the higher expenditure for users and reviewers. A possible future development could be a point-based system similar to StackOverflow, where users get points for good tasks and can also review as they have proven their experience within the system.

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