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Patterns of quiz attempts in a MOOC. The full-points-pattern and other patterns on the way to a successful MOOC in a lecture setting

Abstract: The analysis of learner data in MOOCs provides numerous opportunities to look for patterns that may indicate participants' learning strategies. In this article, we investigated how participants in a MOOC (N=1,200), in which they must successfully complete a quiz in each unit, deal with the fact that they can repeat this quiz up to five times. On the one hand, patterns can be identified regarding the success of the quiz attempts: For example, 32.7% of the course participants always repeat the quizzes up to a full score, while about 16.0% of the participants repeat, but only until they pass all quizzes. Regarding the number of attempts, independent of the success, there is only a uniformity in "single attempt"; 12.6% of the participants only take exactly one attempt at each of the quizzes in the MOOC. An analysis of a subgroup of 80 learners which were students of a course where the MOOC was obligatory, shows that the proportion of learners attributed to patterns making more attempts is generally bigger. It can be shown as well that learners who use several attempts, even after a full score results, tend to get better exam. The article concludes by discussing how these patterns can be interpreted and how they might influence future MOOC developments.

1. Introduction

MOOC designers have some ideas on how learners should learn within a MOOC and create "learning paths" with the help of platform features (such as a discussion forum), their instructional media (video and texts) and assignments (for the discussion forum or quizzes). Of course, learners do not always follow such paths, i.e. they do not view video by video or unit by unit. Anyhow, learners tend to be more successful if they follow the suggested paths in MOOCs (Davis et al., 2016). The following implementation of quizzes in a MOOC for learning assessment and certification is not unusual (Chauhan & Goel, 2016): In the case of the national Austrian MOOC platform iMooX.at, quizzes are typically the last part of each unit. The learners can use them to check whether they learned the basics of the unit. A positive quiz result is also the base for the final participant certification. As quizzes have a double role within the MOOC, participants can repeat them up to 4 times (so 5 trials in total), and the highest grade is taken for the final certificate (if wished or needed); at least 75 percent of the points are needed to pass a quiz. When studying learners' activities in several of our MOOCs, we stumbled upon the fact that there might be different behavior concerning the quizzes: Some participants for example repeat them several times in a short time frame, others make only single attempts. Khalil & Ebner (2015) have already described anecdotal patterns of behavior in a MOOC at iMooX.at (N=269): "Lastly, our observations show that almost the majority of participants are performing better with each quiz attempt. Usually, they stop when their score meets the required passing grade. Nevertheless, others liked to accept the challenge and took the chance to receive the full mark" (p. 1221). In a later analysis of another MOOC where we interpreted quiz results as feedback for learners and made an exploratory analysis of this data (Schön et al. 2021, N=1,484), we have recognized similar activities.

For this contribution, we decided to investigate whether there are such different behavioral patterns or strategies around quiz activities, how they can be described, and how often they occur. We therefore aim for better insights into how learners use and deal with the learning setting of a certain MOOC. So, we see the contribution as an analysis of the extent to which predefined learning structures are used differently (strategically) by MOOC users. Additionally, we anticipate such potential patterns as a resource for future applications of learning analytics, which might give learners reasonable feedback for their learning behavior (see Greller & Drachsler, 2012).

2. Learning strategies in MOOCs concerning quiz results

Chauhan & Goel (2016) distinguish two types of quizzes in MOOCs: (a) independent quizzes as an "autonomous unit" for practice and/or assessment purposes and (b) embedded or in-video quizzes which "facilitates a learner to test their knowledge without worrying about the effect of evaluation on final grading". In the case of the iMooX.at platform, the successful completion of all quizzes (at least 75 percent of the points in each quiz) is the prerequisite for

obtaining a certificate of attendance. To ensure that the quizzes do not only have the character of an exam but are also perceived as learning support and self-monitoring, it is therefore possible to repeat the quizzes. Learners appreciate quizzes in MOOCs because they feel that they are well supported in their learning, at least this has been shown to be true for the quiz feature in Coursera (Anggraini et al. 2018).

Quiz results or feedback in MOOCs can be seen as part of the topic of learning analytics: Data analyses, interpretations, and applications to support individual learning processes are assigned to the area of "Learning Analytics" (Greller & Drachsler, 2012). As quiz results are easy to count and analyze, they are part of the basic elements of a learning management system or MOOC platform. It might be of interest to consider them as helpful criteria to support and guide learners in a MOOC. Although the quiz results and feedback seem to be an obvious criterion for learners' support, there are not many studies on the topic (see also Schön et al., 2021): We found some studies analyzing the relation of quiz activities or results as predictor of the final MOOC success or future activities. For example, Ren, Rangwala and Johriused (2016) apply a multi-regression model to predict performance on the final MOOC assessment, which is a homework task. Data of learners' activities (server logs from EdX courses), for example the number of quizzes or number of logins, was used as a basis for analysis. According to this study, the number of quizzes passed is the strongest predictor for the final assessment, followed by the percentage of videos watched (p. 489). Admiraal, Huisman & Pilli (2015) were able to show that quizzes and peer assessment in a MOOC predict the final grade better than self-assessments.

There are also not many contributions on the question of (learning) strategies or patterns of learner behavior in MOOCs. Milligan, Littlejohn & Margaryan (2013) describe learner types in connectivistic MOOCs, as they are also known from social media applications: Accordingly, there is active participation, lurker, or passive participation. Similarly, Hill (2013) distinguishes four types of participants in MOOCs depending on their behavior: (a) lurkers enroll, but only observe some items, if, (b) drop-ins are partly active, but do not attempt to complete, (c) passive participants in the course act as consumers and do not actively take part in discussion and (d) active participants are active throughout the whole course. However, there is no empirical evidence presented by Hill to support his typology. Berger et al. (2014) show major differences in behavior of participants in their study about the MIT-based edX course Circuits and Electronics: 76 percent of participants account for only 8 percent of the time spent on the course while 7 percent accounted for 60 percent. Anderson et. al. (2014) also classified MOOC participants depending on their behavior. In short, they base their taxonomy on styles of engagement in relation to viewing a lecture and handing in assignments. In conclusion, they give five categories for styles of engagement. Viewers mainly only watch lectures without handing in assignments. Solvers are the opposite type, where participants only hand in assignments and view none or just a few lectures. All-rounders, as the name suggests, are somewhere in between these types. These types are completed by collectors and bystanders. The first ones tend to just collect all the materials they can get from the MOOC, while not handing in assignments or watching many units. Bystanders account for the portion of participants whose total activity is very low. This classification further proves that there are a multitude of interaction types in MOOCs and that a simple expression like completion or viewing rate cannot be enough to justify the success of a course. In addition to this taxonomy, Anderson et. al. (2014) also note that motivations or intentions are another essential factor for a learner taxonomy. Their analysis of the final grades of a machine learning course from Coursera show that on the one hand, about 40% of all participants received a grade of 0 and therefore did not complete the course. However, many of these students were assigned to the viewer type and therefore did not put non-trivial amounts of work into the course. On the other hand, about 10% achieved a perfect score in the same course. These near-perfect students are either assigned to the solver or the all-rounder class. Overall, Anderson et. al. (2014) concluded that MOOCs cannot be understood as "online analogues of traditional offline university classes", but they "come with their own set of diverse student behaviors". There are also other contributions that deal with different learning behavior and learning strategies in MOOCs: Littlejohn et al. (2016) take a closer look at the differences learners have in a MOOC in terms of self-regulated learning (SRL) and how they describe and perceive themselves. Rieber (2017) again looks at different motivations to participate in a MOOC, which learning opportunities participants find helpful and how this affects behavior in the MOOC. Cohen et al. (2019) analyze different learner behaviors in the forum of a MOOC, including the intensity of exchanges and the topics. They also identify five types, ranging from the "super actives" who write numerous posts and tag them, for example, to those who do not participate at all. Rizvi et al. (2020) describe further research and also present an analysis of learner behavior in MOOCs concerning the progress marker, distinguishing "markers", "partial-markers" and "non-markers".

3. Methodology: Research question, approach, and background

We would like to answer the following two research questions in this paper: (a) Are there any patterns in the behavior of MOOC participants regarding quizzes and their repetition in a MOOC? If so, what are they? (b) Do course results differ for students with different quiz patterns in the MOOC? Details of the approach and methods, as well as the background of the specific MOOC, are described below.

There are no specific contributions to the possible behaviors yet, nor could we derive from existing theories of learning behavior concerning quizzes. Therefore, we took an exploratory approach. Firstly, we chose a specific

MOOC to better understand and interpret certain patterns and behaviors from the MOOC context. To give more details, we chose a MOOC which is part of a course offered by six Austrian universities within the framework of teacher training, i.e., successful MOOC participation is a prerequisite for the course. Secondly, we used the data profiles from our MOOC platform, listed quiz behavior by learners and discussed (potential) patterns. In an iterative process, we analyzed the data and checked if and how we could sort the data and identify other learners with similar or same quiz activities. To this end, we repeatedly adapted the model criteria and descriptions and tried to find overlap-free classifications. In addition to this specific exploratory data analysis, we described general user activities using descriptive statistics, and then evaluated this information again for individuals with the different patterns to get a better picture of learners and their (other) behaviors in the MOOC. Besides the handling and sorting of the data, the visualization of the quiz behavior pattern is not trivial. There are some visualizations that we found helpful in this regard (Coffrin et al., 2014, Hill, 2013, Judd & Kennedy, 2004; Davis et al., 2016). Thirdly, with a research cooperation we were able to use data from 117 students of two partner universities, which are the University College of Teacher Education Styria and the Private University College of Teacher Education. For them, the MOOC was obligatory part of a course, and we got their final exam points. We were able to clearly link 80 of them to the data in the MOOC. This data is base for an (also) exploratory analysis, how quiz patterns might be connected to learning results.

The platform and the quiz implementations differ from others: iMooX.at is the Austrian MOOC platform, hosted by Graz University of Technology (TU Graz). Established in 2013, based on the open-source system Moodle, it serves as a nationwide and European-wide platform for online courses following the xMOOC design concept. The course language is mostly German, but there are also several courses in English and other languages. Currently, iMooX.at counts about 50,000 registered users and has hosted more than 200 MOOCs so far. A unique characteristic of iMooX.at is that all courses are licensed as open educational resources (in short OER, Schaffert & Geser, 2008) and therefore available under CC licenses, so it is possible to (re-)use as well as to modify them (Ebner et al., 2016). Several MOOCs are part of lectures at universities or provided by partner universities, so that a variety of design concepts such as blended MOOCs or pre-MOOCs (Ebner, Schön & Braun, 2020) or a design alternative coined as Inverse Blended MOOC (Ebner & Schön, 2019) have already been explored. At iMooX.at the quizzes are a key for learning assessment and certification. These are the conditions regarding the quiz in the analyzed MOOC, which are typical quiz settings on the platform: each unit has a quiz; quizzes can be done up to 5 times; best result is counted; and at least 75% quota for each quiz is needed for certificate.

Within this contribution we analyze the data of the MOOC “Lehren und Lernen mit digitalen Medien II”, a MOOC delivered in academic term winter 2020/2021 addressing the topic “Teaching and learning with digital media” (available at <https://imoox.at/course/LULIWS20>). The MOOC was available for free and open to everyone who wanted to participate and counted 1,200 registered participations at the end of June 2021. However, the development focused on the main target group, future teachers. The MOOC was co-designed by lecturers from six Austrian universities and integrated into their regular lecture system in the second year of studies. The MOOC served as the “lecture” part in a combined “lecture with practical” setting at all partner universities. In other words, the universities asked their students to join the MOOC and additionally take part in a face-to-face practical course. The final grading is based on a final exam with partly the same multiple-choice questions as in the MOOC and a piece of project work. The design of the first part of the MOOC (“Lehren und Lernen mit digitalen Medien I”) is very similar (see Ebner et al., 2020). For previous MOOC implementations, analyses of various kinds have already been carried out and already published (Schön et al., 2021, Ebner et al., 2020, p. 73, Lipp et al. 2021).

The lecture, which uses the MOOC, was conducted for the second time in winter semester 2020/2021, but because of the Covid-19 measures, it was conducted mainly as an online course, meaning that the exercises, except for the first session, also took place online. The MOOC itself had the following units and structure: Unit 1: introduction, Unit 2: Single-board computers, interdisciplinary teaching with digital technologies, Iterative thinking and algorithmizing, Unit 3: Technology-supported problem solving, designing multimedia and interactive teaching and learning materials, Unit 4: Web-based information systems for teaching and learning, e-assessment, Unit 5: effects of digital media in the classroom, and Unit 6: Educational technology - quo vadis, open and participatory teaching and learning concepts. In total, six quizzes as well as 20 videos were provided. The project work deals with the idea to prepare a lesson with a microcontroller (in our case the Microbit) in a non-computer-science subject in a group of up to four students. The students have to prepare a lesson template as well as a solution to the task (e.g. the program for the Microbit) and present it in the final lecture.

4. Results

4.1 General Participation

The MOOC started in October 2020 and was available online for self-study until early July 2021. Within this timeframe, 1,205 registrations for this MOOC and 475 successful participations were counted. For our analysis, the data from the end of June 2021 were taken.

4.2 General quiz behavior

At the end of June 2021, 605 of the 1,200 registered course participants had taken at least one quiz (50.4%) and 472 people (39.3%) had taken all 6 quizzes. 595, that is 49.6% of the 1,200 registered course participants, did not complete single quiz. Fig. 1 gives an overview of the number of people who finished the quizzes successfully.

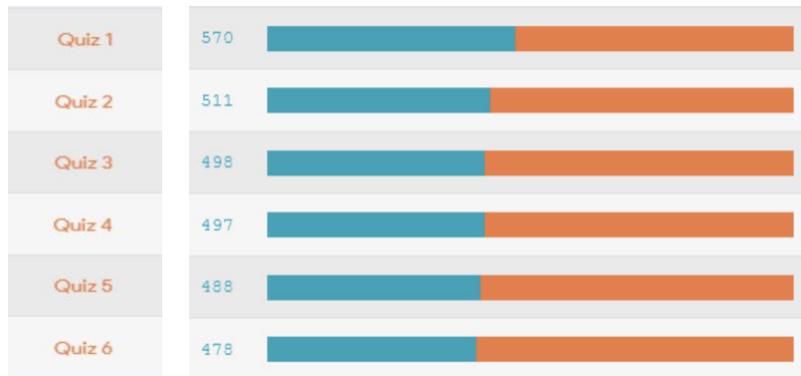


Figure 1: Attempts of quizzes: Distribution over the six quizzes (in relation to 1,205 registered participants). Source: iMooX.at creator's dashboard. Please note: The data used in our following analysis slightly deviates from this image: Quiz 1: 564; Quiz 2: 507; Quiz 3: 494; Quiz 4: 491; Quiz 5: 484; Quiz 6: 473

As described, there are up to 5 attempts possible for each quiz, which is a maximum of 30 possible attempts throughout the entire course. In sum, we count 3,069 quiz attempts, so on average, everyone who has taken quizzes made 5.07 attempts throughout the whole course. We have now analyzed across all quizzes how often attempts were concluded with 10 points (green), or successfully but not with full points (blue) or not successfully. Regardless of the result, the quizzes can be repeated up to five times. This was rarely done when 10 points were achieved, but if full marks were not achieved, another attempt was very often started. We sorted and visualized the attempts and results for all quizzes. Figure 2 shows that the proportion of people with full marks at their first attempt is still quite similar in the second attempt, but by the third attempt it is already very high: Around 53% of those who made a third attempt complete this attempt with full marks. There are only very few who make five attempts but still do not pass the quiz. In absolute numbers, only one person failed quiz 1 despite 5 attempts and only two people failed quiz 2 despite 5 attempts.

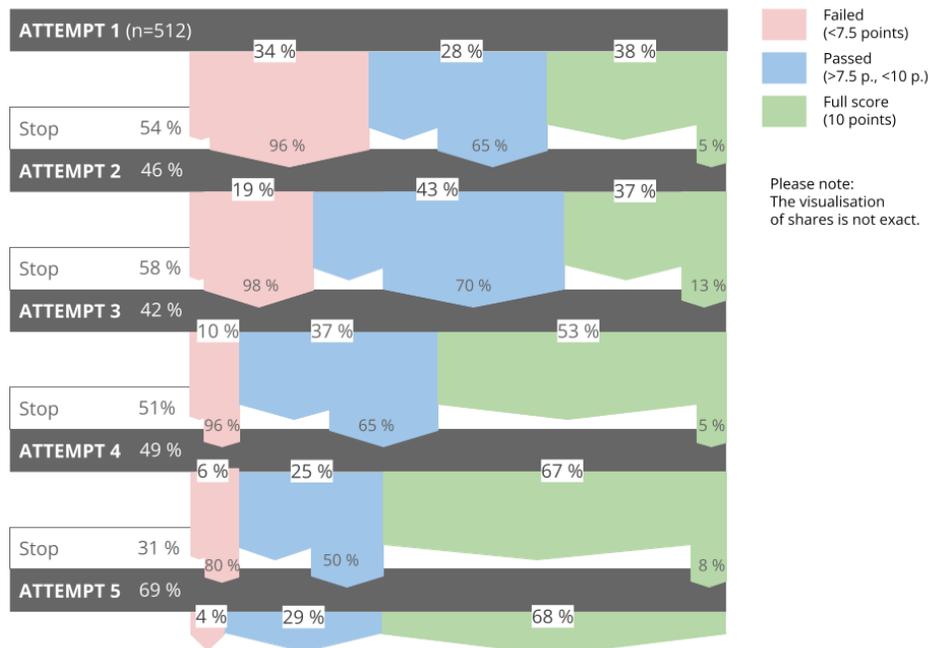


Figure 2. Overview of (up to five) quiz attempts and their results across all six quizzes in the MOOC (n=605). The percentages are the mean values from all six quizzes.

4.3 Identified patterns and quantitative analysis of their frequency concerning failure and success

In this section, we describe the found patterns of quiz behavior. As a first step in identifying possible pattern trajectories of completing each quiz attempt in the MOOC, we first differentiated all course participants into three groups as in our description of the general quiz behavior above: Group A - Full Score: 10 points in each quiz, Group B - Passed: at least 7.5 points in each quiz, and Group C - Failed: less than 7.5 points in at least one quiz or no participation in at least one quiz. Based on our observations of other MOOC quiz results in the past, we then looked for a presumed pattern of quiz behavior within these groups. Are there certain groups of people that always work consistently toward a specific result? We also investigated the question of whether there are patterns in which a certain number of attempts is always made in each quiz.

Group A - Full Score: 10 points in each quiz

Of all the people who made attempts in each quiz (n=472), 219 people (46.4%) scored 10 points on all quizzes after one or more attempts. Theoretically, each participant always has 5 attempts available for each quiz, even if he/she has already achieved the full score earlier. Since the best attempt is the result and for practice reasons, it could well be assumed that course participants will make further attempts even after achieving the full score once. Regarding this fact we analyzed how often participants do not make any further attempt after they have reached the full points once and how often they keep on going even though they have already reached 10 points. Within our data, the vast majority of the 219 people with 10 points in each quiz, 198 people (90.4%) stopped taking further quiz attempts once they reached 10 points. Figure 3 illustrates this pattern I “10 points are enough” schematically.

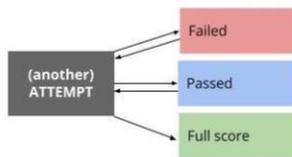


Figure 3: Attempts until 10 points are reached (“10 points are enough”)

But there are some people who also make further quiz attempts after 10-point quizzes, in which they then also score worse in some cases: These are 21 people in total, and they show a certain consistency in their behavior: 15 of these 21 people have done so in all six quizzes: they have thus scored 10 points in all quizzes but (later) carried out further quiz attempts. Another 2 of these 21 people have registered at least one additional attempt after reaching the full score in 5 of the 6 quizzes. The one time they broke the pattern, they almost certainly did so because they did not reach 10 points until the last attempt, so they had no further attempts left. Figure 7 is a slight modification of the pattern illustrated in Figure 4, as here the participants at least once repeated a quiz where they already got 10 points. We call this pattern II “training with a quiz is more important than 10 points”.

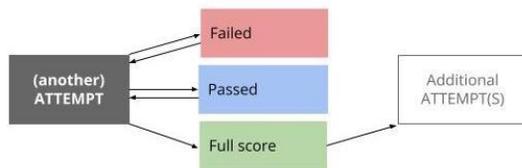


Figure 4: Attempt pattern “training with a quiz is more important than 10 points”

Group B - Passed: at least 7.5 points in each quiz

252 (53.4%) of the 472 people who participated in all 6 quizzes passed each quiz but did not score the full points in each quiz. According to the data of group A, the score histories of these participants were examined to see whether attempts were only made until the quiz was passed (as a minimum of 7.5 points) or if they carried on after passing the quiz once. Again, different patterns emerge: 97 participants make attempts until they have passed the respective quiz for the first time and then stop. We call this pattern III “minimal success”, it is illustrated in Fig. 5.

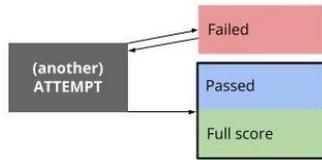


Figure 5: Attempt pattern “minimal success”

Then, there are several people who did not stop immediately after a successful attempt in each quiz. So, they made further attempts without always getting full marks in the last quiz (as opposed to the people in group A). This pattern IV called “passing is ok – but better result would be nice” is shown in Fig. 6. 42 participants made another attempt after an already successful attempt in just one of the six quizzes. So, they broke pattern III just once. This often happened when the first pass was a very close pass (between 7.5 and 8 points). 113 of the participants made one or more further attempts in two or more quizzes even after passing for the first time. If we look at the score progression, we see that even this group might work towards 10 points, but this strategy was not consistently pursued in all 6 quizzes (as opposed to group A). It seems that 8 of these 113 people always worked towards 10 points but had no more attempts to complete that goal. 7 of them scored 10 points in 5 of the 6 quizzes and in the one they did not score 10 points; all 5 attempts were used. One person scored 10 points in 4 quizzes and used all 5 attempts in the other two quizzes. So perhaps they just failed in scoring 10 points although they strived to achieve a full score.

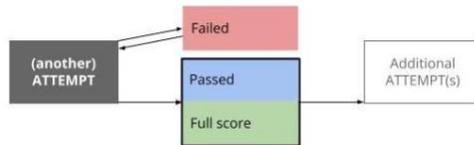


Figure 6: Attempt pattern “passing is okay - but a better result would be nice”

Group C - Failed: less than 7.5 points in at least one quiz or no participation in at least one quiz

Finally, we looked at the group of 134 people who did not successfully complete the overall course. There may be two different reasons for this. On the one hand, it may be that a person simply did not take all six quizzes and therefore failed (since all six quizzes must be completed with at least 7.5 points for successful completion of the course). On the other hand, a person cannot successfully complete the course if he or she took all quizzes but scored less than 7.5 points in at least one quiz. In fact, in our MOOC, only one person who took all six quizzes failed one quiz and thus failed overall. This person failed quiz 2 and used all five possible attempts. So, we can assume that this person has been working towards a successful completion of the whole quiz but failed. Furthermore, this person could probably be assigned to pattern III, since in each of the remaining five quizzes the attempts immediately stopped when the respective quiz was passed (greater than or equal to 7.5 points). The other 133 people in Group C did not participate in each quiz and therefore failed the whole MOOC. 83 of these people (63.2%) participated in only one quiz at all and 55 people (41.4%) made just one attempt in the entire course. We can assume that those people were not really interested in a successful completion of the MOOC and just gave it a try. There is no discernible pattern to their actions.

4.4 Identified patterns and quantitative analysis of their frequency concerning a fixed number of attempts

While searching for the patterns described above, we came across another possibility of a specific quiz approach. We conjectured that the participants may always use a certain number of attempts in all quizzes regardless of their respective performance in the quiz. The analysis revealed that a total of 76 of the 472 participants who did all quizzes (16.1%) made only one attempt in all 6 quizzes and passed the quiz - so “one single attempt is enough”. Figure 7 illustrates this simple pattern V.

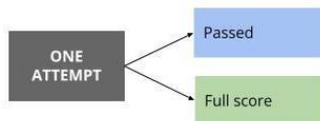


Figure 7: The single attempt pattern

If we look at the quiz performance of these 76 people in Table 4, we see that not even one of these individual attempts was negative (< 7.5 points). All attempts registered a score of 7.5 or higher, so none of these 76 people failed any quiz. The situation is different concerning a potential strict approach to only make more than one, but a certain number of attempts per quiz. The data analysis revealed that in the present MOOC not a single person took 5 attempts in all 6 quizzes. Thus, not a single course participant made use of the full number of available attempts. Furthermore, among the 472 participants who took all 6 quizzes, there was only one person who always took 2 or 3 attempts and only 2 people who took 4 attempts in each quiz. So, we could not see a pattern regarding 2 to 6 attempts in each quiz.

4.5 Relation of patterns and overlaps in numbers

Thus, by looking at and sorting the data, we have identified different groups of patterns. There are clear demarcations between the patterns related to the result (best quiz attempt) (all with 10 points, all successful but less than 10 points or at least one unsuccessful attempt, i.e., Pattern I - IV). We also found a pattern of people who always made only one attempt in each quiz (Pattern V). The latter pattern overlaps with two groups that relate to the success of the quiz. We have illustrated this relationship in Figure 8.

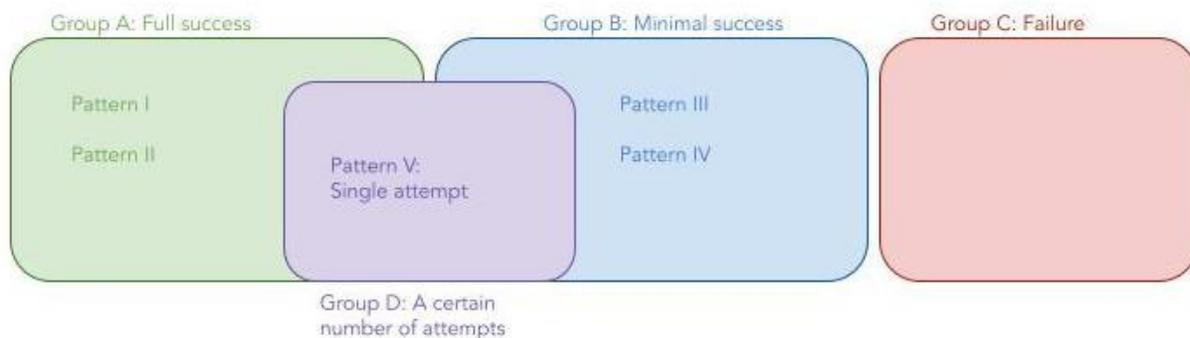


Figure 8: Different groups of patterns were identified and found

The participants with pattern V, so one single attempt, can be assigned to 2 of the 3 groups listed above: (a) Group A (10 points in each quiz): 44.7% of the 76 participants that only used one attempt in each quiz achieved the full score - i.e., 10 points - in all 6 quizzes with this one attempt. (b) Group B (at least 7.5 points in each quiz): 55.3% of the 76 participants that only used one attempt in each quiz passed every quiz (7.5 or more points) but did not achieve the full score in all 6 quizzes. More precisely, pattern VI (One attempt is enough) overlaps with the two described patterns I (10 points are enough) and III (Passing is enough). 17.7% of the participants in Pattern I and 43.3% of those in pattern III can also be assigned to the one-attempt-pattern. The one attempt pattern would also be possible in group C (i.e., only one attempt, which failed), but there is no such case in the MOOC.

4.6 The five patterns briefly

The following Table 1 presents all the main descriptive characteristics in terms of the number of quizzes attempted, the results and the proportion of all participants in the MOOC.

Table 1: The identified five patterns and their average quiz attempts, highest score, and percentage of participants (n=605, everyone with at least one quiz)

Pattern	Description	Average number of quiz attempts	Average highest score	Percentage of participants
I	10 points are enough	1.9	10	32.7%
II	Training with a quiz is more important than 10 points	3.5	10	3.5%
III	Minimal Success - passing is enough	1.4	9.38	16.0%
IV	Passing is ok - but a better result would be nicer	2.3	9.63	25.6%
V	One single attempt is enough	1	9.80	12.6%

4.7 Quiz patterns and course success: Insights from a subgroup of students

Some of the MOOC participants provided us with data on their learning success in the course in which the MOOC was the lecture part (see section 3.5). These were 117 students from two University Colleges of Teacher Education who did the whole lecture. All students passed it. We were able to clearly link 80 of them to the data in the MOOC. Table 2 presents the distribution of quiz patterns of these students within the MOOC and their course result amongst these 80 students.

Table 2: Quiz pattern of all MOOC participants and 80 students who successfully completed a course with the successful MOOC as obligatory lecture (best result: 100 points).

Group	all (n=605)	Subgroup (n=80)	Pattern	all (n=605)	subgroup (n=80)	Exam results of subgroup (mean)	95%-confidence-interval	
							lower bound	upper bound
A - Full Score	36,2%	55,0%	I	32,7%	43,8%	80,12	76,89	83,34
			II	3,5%	11,3%	88,32	80,67	95,97
B - Passed	41,6%	45,0%	III	16,0%	11,3%	77,32	69,77	84,86
			IV	25,6%	33,8%	81,70	77,73	85,68
C - Failed	22,2%	0,0%	none	22,2%	0,0%			
Sum	100,0%	100,0%	Sum	100,0%	100,0%			

As can be seen, the distribution of the quiz patterns shows a different distribution of the identified quiz pattern in this subgroup. Practically, we see especially that these students have bigger shares of the full score pattern than MOOC participants in general. They as well more often make more attempts even after a full score (pattern II) or after they passed (IV) than MOOC learners. Interestingly, we as well see that the learners in pattern I do not have an expected high average exam. This leads to the suspicion that some of these are learners who have cheated on the quizzes. Additionally, we see that pattern II is connected to a higher final grade in the lecture. This could be interpreted in the way, the learning with quizzes is helpful with the final course exam. Since questions from the MOOC are also used in the exam, this is not very surprising. At the same time, it could also be that the students who continue to practice with the quizzes even with full scores are particularly ambitious learners.

5. Summary and discussion

Finally, we would like to summarize the answers found to the research questions and then discuss them. Based on the data available to us on the quiz attempts and results in the MOOC we selected, five patterns have emerged. These are specific sequences of attempts and results that are detectable in the same way for several participants. We were interested in patterns that led to successful completion of the MOOC. We were able to

identify four patterns in relation to the success of the attempts, in terms of the frequency of attempts, we could only see one pattern with single attempts (see Table 4).

A subgroup of 80 learners of the MOOC were students in a course where the participation at the MOOC was obligatory and where we could combine their quiz pattern with their exam result. There we can see that the proportion of learners attributed to patterns that make more attempts is generally bigger. It can be shown as well that learners who use several attempts, even after a full score results, tend to get better exam.

In general, we think that our approach and results are original and may give interesting insights into how (different) people use MOOC infrastructure and learning opportunities. Also, not all MOOC platforms use the same approach of quizzes that can be repeated, and which are as well part of the final assessment are not usual. However, this raises some questions for further use and investigation. The first question is if these patterns of behaviors might as well be patterns of strategies. Throughout this article we have only talked about patterns of behavior and the question arises whether there are also certain intentions and strategies behind them. The question is whether the participants are aware of these patterns and implicitly or explicitly pursue strategies such as "as little effort as possible" or "always 10 points". A second question might be whether these patterns are distinctive and original (enough). The first four patterns all describe variants of behavioral patterns in relation to success, i.e. each participant can be assigned to exactly one pattern. However, the one-attempt pattern in particular shows that there are also corresponding or competitive patterns. In this context, we cannot say which is the stronger pattern in each case. We do not know if the people in question were primarily trying to achieve a certain score or if they were just strictly using one attempt in each quiz. A third question touches on the generalizability of the results, for example concerning the frequency of these patterns amongst quiz participants or MOOC participants in general. This is to be questioned critically for several reasons. Most participants were students for whom participation is obligatory, so there was also particularly high motivation to pass the quizzes. Also, because of this, the present MOOC was completed very successfully by most participants (there are hardly any people who failed a quiz and many who scored 10 points in all quizzes). Then as well, such strategies might be culturally influenced: Paphthoma et al. (2015) emphasize that - as qualitative interviews show - the differences in the perception of different assessments in MOOCs, especially in the perception of automatic feedback or peer assessment, may also be related to different cultural backgrounds and previous experiences.

6. Outlook

We are encouraged by the results of our research to investigate to what extent we can find the identified patterns in the other MOOCs on the iMooX.at platform, and in what distribution. At the same time, we are aware that interviews are also needed to determine whether and in what way participants are aware of corresponding behaviors or use them strategically. Such results would of course be very exciting in comparison with other MOOCs.

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