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Motivation for learning in campus-integrated MOOCs: Self-determined students, grade hunters and teacher trusters

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ABSTRACT

Massive Open Online Course (MOOC) integration into campus education is rising, in many different forms. When integrating MOOCs, motivation to learn demands consideration as it is related to academic achievement and well-being. Student motivation in formal integrated MOOC learning is understudied. This study aimed to characterize the shape of motivation to learn in integrated MOOC learning. Motivation profiles of undergraduate students that learn in three different MOOC integration designs were explored, as was the distribution of profiles among integration designs. Finally, factors that underpin motivation were compared between integration designs. Six motivation profiles were recovered through a two-step cluster analysis: Self-determined students, highly self-determined students, grade hunters, and teacher trusters who are moderately, highly, or extremely trusting. Proportions of motivation profiles differed significantly between MOOC integration designs, and psychological needs were satisfied and frustrated significantly different between designs. Implications for future MOOC integration research and practice are discussed.

List of abbreviations

AVG	Dutch general data protection regulation
PCA	Principal Component Analysis
ERRB	Educational Research Review Board
Hons	Honours college
LOTS	Leiden Oxford Summer School
LUMC	Leiden University Medical Center
MANOVA	Multivariate Analysis of Variance
MOD	Mechanisms of Disease
MOOC	Massive Open Online Course
VRC	Variation Ration Criterion

1. Introduction

When first introduced, Massive Open Online Courses (MOOCs) were said to be a disruptive innovation that would be able to change the higher education model [1,2]. Many universities that created MOOCs, have also integrated these courses into their regular campus teaching [3,4]. This has many advantages for both teachers and students [5,6]. Several institutions are now connected to exchange initiatives to offer students MOOCs from other institutions [7]. In this respect, MOOCs are indeed changing the higher education model as many different forms of MOOC integration designs are being experimented with worldwide.

When addressing MOOC integration, it is important to consider the difference between formal learning and non-formal learning. Formal learning has been defined as learning that occurs in structured, organised environments, which is aimed at fulfilling learning objectives [8]. Typical examples include the initial education and schooling system and workplace training organised by the employer. Non-formal learning 'may occur at the initiative of the individual but also happens as a by-product of more organised activities, whether or not the activities themselves have learning objectives'. MOOCs are organised activities, often with learning objectives [6]. However, if they are part of one's formal education depends on the fulfilment of formal certification. In this study, if students learn in (parts of) a MOOC that the institution or teachers endorse as part of the offered, credit-bearing curriculum, we consider it to be (formal) MOOC integration. For clarity, we will refer to

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students as students in a formal learning environment, and as learners when they participate in a non-formal MOOC.

Specific approaches to formal MOOC integration have been described, often as a single context for research or as case studies [9–13]. In addition, facilitators and barriers to learning in an integrated MOOC have been described, indicating that making the MOOC an obligatory activity was needed to motivate students to complete it [14]. MOOC integration designs can be characterised by decisions about '1) level of education, 2) degree of obligation, 3) ratio of online versus face-to-face teaching, 4) replacing or adding MOOC content to formal courses, and 5) level of contact with other online learners in the MOOC' [6]. Some studies have compared multiple ways of integrating MOOCs, finding that in blended designs student outcomes are equal or improved compared to fully online or traditional face-to-face designs [15,16]. Studies that investigate multiple integration designs are scarce, however, while this might offer more insight into what works when.

Motivation to learn is highly influential for learning in both formal and non-formal settings. It has been studied in depth in non-formal MOOC settings, where learners follow a MOOC on their own initiative [4,17], but not in integration settings, which can be characterized as mainly formal learning [6]. In this regard, an important difference between non-formal and formal MOOC learning is, that formal learning implies that external factors also influence motivation to learn, such as grades or expectations from others. As one of the choices in MOOC integration design regards the degree of obligation to participate in the MOOC, we foresee that design choices could influence motivation to learn and the related outcome measures considerably. The current study aims to contribute insights into how students' motivation in existing integration settings can be characterized. This characterization will 1) help to understand the effects that MOOC integration can have on motivation to learn in them, 2) offer direction for future intervention studies with integrated MOOCs, and 3) inform efforts to offer more effective and personalized learning experiences with integrated MOOCs.

1.1. Overview of the literature

1.1.1. Motivation for learning in non-formal MOOCs

Over the last few years, motivation for learning in MOOCs has been a focal point in MOOC research [4,18], as it has a great influence on engagement [19,20]. Furthermore, it is closely related to self-regulated learning which is essential for learning in MOOCs [17]. Many studies focused on what motivates students to participate in a MOOC or to complete a MOOC [19]. In this regard, Kizilcec and Schneider [21] developed the Online Learning Enrolment Intentions (OLEI) scale with thirteen different intentions to enrol in non-formal MOOCs, including most of the reasons for enrolment found in other studies, for example, Huang and Hew [22] and Loizzo et al. [23]. Luik et al. [24] developed the 'Factors Influencing Enrolment in MOOCs scale', and compiled with the OLEI scale, reported reasons for participation include 1) interest in a topic, 2) relevance to job, 3) school or academic research, 4) personal growth, 5) career change, 6) fun and challenge, 7) to meet new people, 8) to experience an online course, 9) to earn a certificate, 10) prestige of the university or professor teaching, 11) taking the course with friends or colleagues, and 12) to improve English skills [21,24].

As MOOCs matured, data from many studies showed that MOOC completion is often very low. This prompted researchers to investigate causes for dropout [25,26], reasons for persisting to learn in a MOOC [17,27], and factors related to completion [28,29], and to discuss the definition of successful learning in MOOCs. The new lens to define successful MOOC learning is based on the notion that non-formal MOOC learners are often self-directed, meaning they decide their own learning objectives, and when these have been met, completion of the MOOC is unnecessary [23,30]. Successful non-formal MOOC learning is thus more defined by learner satisfaction and personal goal attainment than completion, and MOOC platforms have accommodated this new standard by asking learners for their personal goals when enrolling in a MOOC, and learning analytics are being employed to offer personalized experiences [30].

While completion is no longer the sole desired outcome, studies on completion did show that positive motivation was related to positive engagement [31], participation, and to the inclination to complete a MOOC [28,32]. In addition, research has been directed at discovering how motivation to learn in a MOOC influences other variables such as retention, self-regulated learning and academic achievement [18]. Through a systematic literature review Badali et al. [19] found that need-based academic motives including intrinsic goal motivation were most important for retention directly, and indirectly via self-regulation, performance and engagement among others. In addition, several studies found that intrinsic motivation specifically played an important role and related to better Self-Regulated Learning [33], performance [34,35], and participation [36,37], which in turn related to completion. Finally attention has been devoted to promoting motivation through design measures, although MOOC course design specifically has been understudied [17,18].

1.1.2. Motivation for learning of university-affiliated MOOC learners

Although motivation significantly influences MOOC learning and MOOCs are being integrated into campus learning, little attention has been dedicated to the motivation of university students who attend MOOCs as part of their studies. We only found literature regarding university-affiliated MOOC learners, i.e. non-formal MOOC learners who are also university students, but do not attending a MOOC that is formally integrated into their curriculum. Semenova [38] found that for university-affiliated MOOC learners, taking the course out of interest and to earn a certificate both positively related to earning a MOOC certificate, and that amotivation was negatively related to it. In this study, the MOOCs had thus not been integrated into the formal curriculum. Watted and Barak [39] compared motivation of two groups of MOOC completers: general non-formally learning participants and university-affiliated learners. The university-affiliated learners were mostly motivated by earning a certificate and general interest, and the general learners were mostly motivated by general interest and (improving) professional competence. For the university-affiliated learners, a negative relationship was found between their two motivations, learners who were highly intrinsically motivated were less extrinsically motivated, and vice versa. Finally, Formanek et al. [40] compared motivation of non-formal astronomy MOOC learners with motivation of their university students in a similar introductory astronomy course and found that the university participants had significantly lower intrinsic motivation, self-efficacy, and self-determination. University students scored higher on social motivation, grade motivation, and career motivation, however.

1.1.3. Theoretical lens: Self-Determination Theory

Intrinsic motivation, characterized as important for MOOC participation and completion, is an extreme on the motivation continuum described by Self-Determination Theory (Fig. 1) and is related to enjoyment and interest [41,42]. It belongs to the act of doing something without external reward or punishment. On the other extreme, amotivation exists, constituting a lack of motivation. In the middle are several forms of extrinsic motivation, which encompass that one is motivated for external reasons. These forms are external regulation of motivation: conforming to a rule due to pending punishment; introjected regulation of motivation: accepting someone else's rule; identified regulation of motivation: understanding of the importance of a rule; and integrated regulation of motivation: integrating a rule with personal values and norms. These are, in this order, increasingly more close to personal norms and values and thus intrinsic motivation [41]. Intrinsic and extrinsic motivation can also be divided differently, into autonomous motivation and controlled motivation, the first including intrinsic motivation and internalized and identified forms of extrinsic motivation, and the second consisting of external and introjected forms of extrinsic

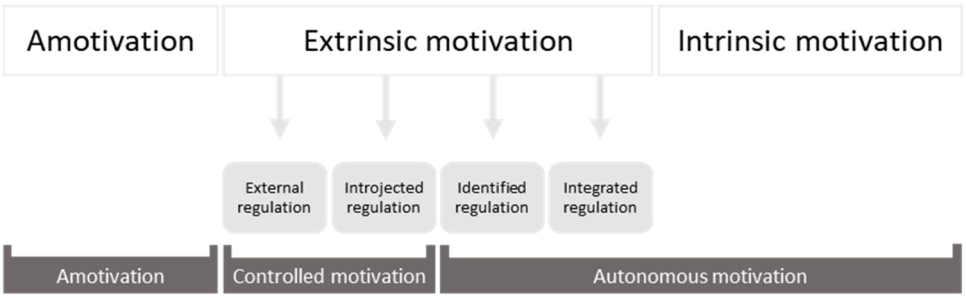

Fig. 1. Motivation continuum according to Self-Determination Theory.

motivation [43]. This categorization is important in formal learning contexts as formal learning is rarely purely intrinsically motivated. Often learning in school or university is extrinsically motivated, however through identification or internalisation of the learning goals, students can feel autonomously motivated. Autonomous motivation has been thoroughly researched in educational contexts and is related to well-being, enjoyment, deep learning strategies and academic achievement [41,44].

A meaningful distinction also exists between quality and quantity of motivation [41]. High-quality motivation consists of high autonomous motivation and low controlled motivation, while high-quantity motivation consists of high autonomous and high controlled motivation (Fig. 2). Thus total motivation can be high, however when it is only or highly externally regulated, or controlled, it is considered low-quality motivation or high-quantity motivation [45]. High-quality, mostly autonomous motivation is internally regulated to a greater extent, and it is positively associated with deep learning strategies, academic achievement, well-being and enjoyment [41,44]. In line with this, Vansteenkiste et al. [45] have found that high-quality motivation in students is related to higher academic achievement and Self-Regulated Learning. Thus, high-quality motivation, e.g., high autonomous motivation and low controlled motivation, is desired. Furthermore, according to self-determination theory there is a psychological need for feelings of autonomy, competence, and relatedness to others in order to be autonomously motivated. In educational settings, these feelings may be satisfied or frustrated. In this way, instructional designs such as MOOC integration designs can influence the amount of autonomous motivation a student experiences, consequently influencing the quality of motivation [44,46].

1.1.4. Motivation profiles

When designing for MOOC integration, learning can also be personalised by adjusting pedagogy and online environment according to the motivation of students, to help personal performance [47]. Grasping the shape of the motivation students feel for learning is therefore essential. This is no easy feat however, as students in online or blended environments are often heterogeneous in their motivation and can have multiple motivations [48]. Profiling can facilitate the design process as it provides a holistic model of learners and students, offering a tool for informing and justifying MOOC designs [49]. A motivation profile describes how the multidimensional configuration of motivation components is organized within individuals. It can be characterized as a specific, relatively recurrent outcome on a set of accumulated motivation components, whereby the theoretical lens often determines the inserted motivation components. Previously, motivation profiles of university students learning face-to-face, online, or blended have been discerned, describing clusters of students with high-quality, high--quantity, low-quality and low-quantity motivation, based on Self-Determination Theory [45,48]. Motivation profiles of non-formal MOOC learners have also been determined, resulting in clusters of opportunity motivated, over-motivated, success motivated and interest motivated students, based on motivation components found in non-formal MOOC learners [32]. Profiles of university students formally learning in integrated MOOCs have not been described. To support integrated MOOC learning, motivation profiles could be used to tailor, for example, assessment [50]. Moreover, targeting students with low-quality motivation seems desirable especially, as students with highly controlled motivation tend to engage less with online course materials [20].

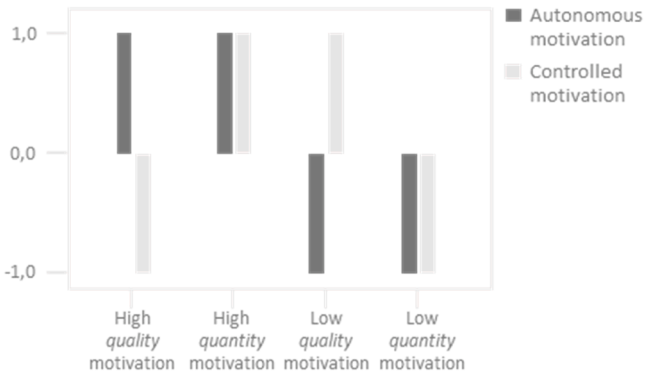

Fig. 2. Figurative explanation of quality and quantity of motivation based on e.g. Vansteenkiste et al. [45].

1.2. Research aims

Design of non-formal MOOC learning has been adjusted according to research findings about motivation to learn in them, however research on motivation to learn in formally integrated MOOCs is lacking. Based on our information, no studies have been conducted to characterise or compare motivation of students in multiple integrated MOOC settings. Knowledge of motivation among students in specific MOOC integration designs, and levels of satisfaction and frustration of the underlying psychological needs is necessary to inform future research and practice of MOOC integration.

This study aims to gain insight into the presence of specific motivation profiles and their foundation in different MOOC integration designs, and possible improvements. Moreover, this study reveals motivation to learn in integrated MOOCs based on students' authentic learning experiences, which might indicate potential inconsistencies or agreements between motivation theories, and MOOC integration practices to consider. It will be the first to characterise motivation to learn in formally integrated MOOCs, and the first to compare integration designs based on motivation.

The research questions of this study are:

1. *What are motivation profiles of students in three different MOOC integration designs?*
2. *How are different MOOC integration designs related to motivation profiles?*

3. *How are psychological needs of students satisfied or frustrated in different MOOC integration designs?*

2. Material and methods

2.1. Research design

A cross-sectional descriptive research design was employed to describe, characterise and compare the shape of motivation in three authentic MOOC integration designs. The variety of motivation profiles was discerned to answer RQ1. To answer RQ2, we calculated the significance of dispersion of motivation profiles over MOOC integration designs. To answer RQ3, we compared scores for psychological need satisfaction and frustration between MOOC integration designs.

2.2. Context description and participant selection

The study was conducted at a medical school in the Netherlands. Three MOOC integration designs for undergraduate students using a MOOC on Clinical Kidney, Pancreas and Islet Transplantation [51] were selected for this study and all enrolled students were invited for participation, as previously described and depicted in [52]. In Fig. 3 the MOOC integration designs have been outlined, and in Fig. 4 the MOOC teaching mode profile and the final teaching mode profiles of the integration designs are summarised.

Integration design A includes completion of a MOOC prior to enrolling in the 3.5-day undergraduate "Leiden Oxford Transplant Summer School" (LOTS), running every July, except in 2020 due to COVID19 restrictions [53]. Enrolment in this LOTS program is voluntary and student admission is based on an application letter. However, once admitted to the program, completion of the MOOC is a prerequisite for admission to the face-to-face meeting. Students sign up for the MOOC individually and learn with other global MOOC learners. About 20 students take the LOTS program each year, as was the case for the current cohort. Prospective participants from integration design A studied MOOC-content between May 2019 and July 2019.

Integration design B is a compulsory 8-week second year course called "Mechanisms of Disease". At the end of the course a full week of lectures has been replaced by a set of MOOC activities. The entire cohort of about 300 yearly students enrols in a single separate iteration of the MOOC, so there is no connection to MOOC learners outside the cohort. The current cohort comprised of 358 students, who studied MOOC-content between September 2019 and October 2019.

Integration design C is an elective for undergraduates enrolled in the Leiden University Medical Center Honours Program [54]. The Honours program is designed for students who desire more challenge in their studies. All students in this integrated design must complete the MOOC at any time during their first or second year of undergraduate studies and must submit additional written assignments. Students will not have face-to-face interactions with other students as this is an individual online course. Between 14 to 18 students participate in this integrated design each year. In total 27 prospective participants from integration design C studied MOOC-content between May 2019 and November 2020.

2.3. Data collection

Email addresses were accumulated through coordinators of the integrated MOOC design courses. The first author contacted students via email to inform them about the study when they enrolled for the selected courses, before commencing the MOOC part. She had no educational role in relation to the students in these cohorts. Furthermore, a notification was placed on the Learning Management System. Students received a document with further information about the study, aspects of their participation and a form regarding informed consent (Appendix A). After finalising the MOOC element of each course, students were approached in person after an exam, or before or after a workgroup or lecture for integration designs A and B, and online for integration design C. They received the information and informed consent again, followed by the questionnaire. All written questionnaires were digitised, and the digital files were checked for mistakes in input.

2.4. Measures and materials

To answer our research questions two primary outcome measures were selected: motivation and psychological need satisfaction and psychological need frustration. Instruments were adapted to learning in MOOCs, tested in think-aloud sessions in three iterations with a different student and combined in a questionnaire.

Motivation. The Learning Self-Regulation Questionnaire [55] is comprised of 12 items and constructed to measure autonomous and controlled motivation on a 7 point Likert-scale. Reported Cronbach's α's are 0.80 for autonomous, and 0.75 for controlled motivation.

Psychological Need Satisfaction and Frustration. The Basic Psychological Need Satisfaction and Frustration Scale [56] is comprised of 24 items on a 5 point Likert-scale. It yields scores for satisfaction and frustration of the psychological needs autonomy, competence and relatedness. The reported Cronbach's α's are between 0.71 and 0.88 for subscales.

2.4.1. Principal component analyses and reliability tests

To ascertain the internal validity and reliability of the two instruments, Principal Component Analyses (PCA) were performed with an oblique rotation with minimization method, and Cronbach's α were calculated. Principal component loading significance was determined according to sample size thresholds described by Hair [57] as sample sizes differed between items due to missing data. These thresholds describe the minimum loading that is needed per item for a specific sample size, and can be found in Appendices B and C.

Motivation to learn. PCA revealed 3 components in our study instead of the 2 components predicted by the instrument description. The components were 1) autonomous motivation, students being motivated to learn in a MOOC because they find it interesting or they want to learn; 2) instructor trusting motivation, students being motivated to learn in a

Integration Design	Level of Education	Degree of Obligation	Online – F2F ratio	Replacement or addition	Contact with other MOOC learners
A (LOTS)	Undergraduate	Compulsory MOOC component in a voluntary course	4 weeks – 3.5 days	Addition	Full access
B (MOD)	Undergraduate	Compulsory MOOC component in a compulsory course	1 week – 7 weeks	Replacement	Separate, private version of the MOOC
C (Hons)	Undergraduate	Voluntary MOOC component in a voluntary course	4 weeks – none	New course	Full access

Fig. 3. MOOC integration designs.

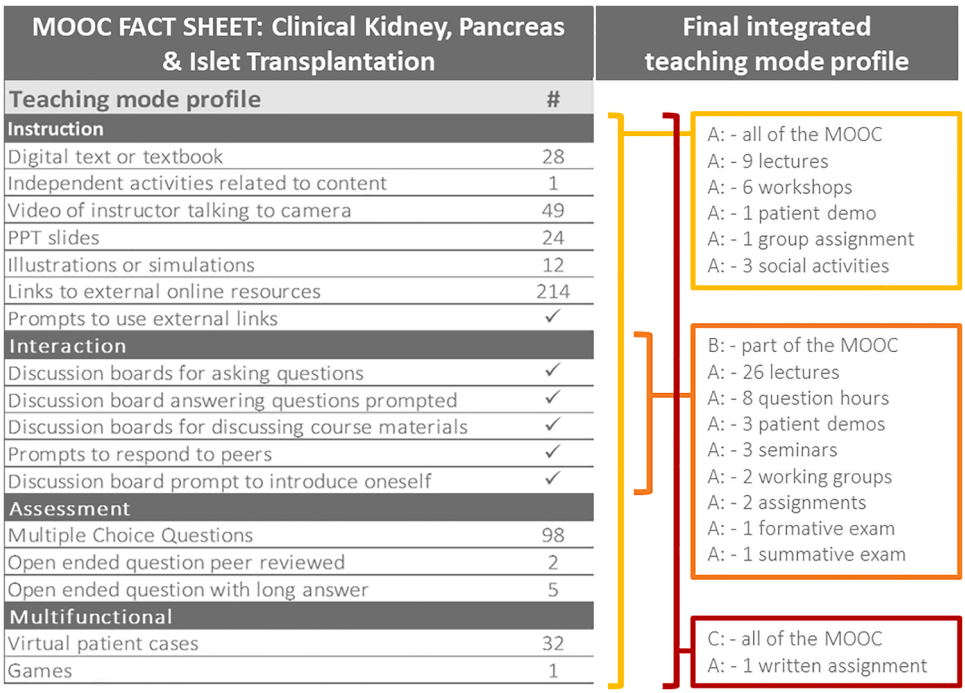

Fig. 4. MOOC teaching mode profiles for integration designs A (LOTS), B (MOD), and C (Hons).

MOOC because they trust their instructor to guide them and to know what's best; and 3) positive image motivation, students being motivated to learn in a MOOC because they want to be perceived positively. Combined the components explained 61 % of the variance. Cronbach's α scores of 0.836, 0.705 and 0.634 were obtained, respectively. The items and component loadings can be found in Appendix B.

The motivating components could not all be categorized as strictly autonomous or controlled. However, the recovered components of instructor trusting motivation and positive image motivation seem similar to motivation components described in previous non-formal MOOC research [24,58], and they resonate with findings from a previous qualitative study in this group of students, where we found that "trust in the teacher" is a major driver for learning strategies (Authors, *submitted*). Furthermore, wanting to be perceived positively certainly fits in the competitive context of (bio)medicine where people want and need to distinguish themselves to secure desired further study or employment positions [59,60].

Psychological need satisfaction and frustration. The final two PCA's with oblique rotation with minimization methods revealed that for psychological need satisfaction, relatedness and autonomy partly loaded together, and that for psychological need frustration, competence and relatedness loaded together, resulting in the following components: 1) relatedness-autonomy satisfaction, 2) competence satisfaction, autonomy satisfaction, 4) autonomy frustration, and 5) competence-relatedness frustration. The components of psychological need satisfaction combined explained 60 % of the variance, and the components of psychological need frustration combined explained 51 % of the variance. Cronbach's α scores of 0.819, 0.794, 0.456, 0.836 and 0.798 were obtained, respectively. As a score of 0.456 is unacceptable, component 3: autonomy satisfaction was left out of further analyses. The items and component loadings can be found in Appendix C.

2.5. Analyses

For RQ1, cluster analysis consisted of Ward's hierarchical clustering followed by K-means clustering to form the clusters, a double split cross validation to discern the stability of the cluster solution, and finally a multivariate analysis of variance (MANOVA) to discern to what extent the constituting motivation dimensions contributed to the cluster solution.

Prior to cluster analysis normal distributions were tested and means were calculated for autonomous, teacher trusting, and positive image motivation based on the maximum number of items or maximum minus one with a minimum of two, for each scale. This means that autonomous motivation was calculated based on a minimum of five out of six items for each participant. This was followed by finding and discarding multivariate and univariate outliers as these can disturb cluster formation. In total data from ten participants was excluded from further analysis due to missing data ($n = 6$), multivariate outliers ($n = 1$) and univariate outliers ($n = 2$).

Ward's hierarchical clustering was performed forming 2 to 10 clusters, yielding nine different cluster solutions. Sums of squares between groups and within groups for each cluster solution were used to calculate the Variance Ration Criterion [61] to discern the optimal cluster solution. This is calculated as the optimal ratio between the variance explained by the cluster solution, compared to the total variance (or variance between the clusters), the number of clusters (criterion of parsimony) and the number of units to be clustered. The optimal number of clusters of $K = 6$ was obtained, as can be seen in Table 1. For the optimal cluster solution, Ward's cluster seeds were recorded to base the non-hierarchical K-means clustering upon. This yielded a final cluster solution and final K-means cluster seeds.

Labels for clusters were based on higher scores for specific components within a cluster, and in comparison to other clusters. For example, the first two clusters show similar high scores for autonomous motivation, substantially lower scores for teacher trusting motivation and even lower scores for positive image motivation. With respect to the other clusters, student motivation in these clusters is distinctively less controlled and so students are more self-determined. As the second cluster has higher scores for the controlled forms of motivation, we labelled the first cluster 'Highly self-determined' and the second 'self-determined'. Labels were first created within the research team and clarity and appropriateness of the labels were discussed with the education research group of Leiden University Medical Center as a form of peer debriefing.

The double split cross validation [45] was performed by randomly

Table 1
Variation Ration Criterion calculation results, showing an optimal combination of parsimony, a high VRC score and a low (negative) Omega score for the cluster solution when 6 clusters are formed. Abbreviations: SSB - sum of squares between clusters; SSW - sum of squares within clusters; N - number of participants; K - number of clusters; VRC: Variation Ration Criterion.

	Motivation dimension											
	Autonomous	*Teacher trusting*	*Positive image*	*Total*	*N*	*K*	*SSB/K-1*	*SSW/N-K*	*VRC*	*Difference a*	*Difference b*	*omega*
SSB10	168,644	236,37	255,314	660,328	263	10	73,370	0,918	79,886	–	−0,794	–
SSW10	70,388	92,939	69,036	232,363								
SSB9	164,852	222,214	253,531	640,597	263	9	80,075	0,992	80,680	−0,794	−2402	1608
SSW9	74,18	107,095	70,819	252,094								
SSB8	161,363	220,66	238,563	620,586	263	8	88,655	1067	83,082	−2402	−0,893	−1509
SSW8	77,669	108,649	85,788	272,106								
SSB7	141,122	217,517	233,298	591,937	263	7	98,656	1175	83,975	−0,893	−1119	0,226
SSW7	97,911	111,793	91,053	300,757								
SSB6	117,723	212,74	226,066	556,529	263	6	111,306	1308	85,094	−1119	−0,152	−0,967
SSW6	121,31	116,57	98,285	336,165								
SSB5	104,429	203,206	200,55	508,185	263	5	127,046	1490	85,246	−0,152	−2584	2431
SSW5	134,604	126,104	123,801	384,509								
SSB4	99,826	154,709	195,646	450,181	263	4	150,060	1709	87,830	−2584	−10,035	7451
SSW4	139,206	174,6	128,704	442,51								
SSB3	40,946	147,067	195,386	383,399	263	3	191,700	1959	97,865	−10,035	−17,912	7876
SSW3	198,086	182,242	128,964	509,292								
SSB2	30,282	50,473	193,553	274,308	263	2	274,308	2369	115,777	−17,912	–	–
SSW2	208,75	278,836	130,798	618,384								

splitting the sample in two and following the cluster-forming steps described above. This yielded final cluster solutions and final K-means cluster seeds for group A and group B. K-means cluster seeds from group A were used to base K-means clustering of group B upon and vice versa. The orders of clusters formed for A and B were then matched to the likeness of the order of the original final cluster solution by hand, so that the K-means cluster seeds of each cluster were similar to each other across the original, group A and group B. Finally, Cohen's kappa's were calculated to discern reliability between the original cluster solution and A and B, which informed us of the stability of the cluster solution. The double split cross validation yielded a Cohen's Kappa of 0.547 for stability of the cluster solution.

For the cluster solution to be acceptable, a minimum of 50 % variance should be explained by the constituting motivation components [45,62]. In a MANOVA constituting dimensions of the clusters were added as dependent variables. This was to discern to what extent each type of motivation contributed to the cluster solution. The constituting dimensions included the three forms of motivation found in the PCA, and based on literature, quantity of motivation, and quality of motivation A and B. As instructor trusting motivation can consist of both autonomous and controlled forms of regulation, two types of quality of motivation were calculated. Quality of motivation A was calculated as Autonomous motivation and Instructor trusting motivation combined, minus Positive image motivation. Quality of motivation B was calculated as Autonomous motivation minus Instructor trusting motivation and Positive image motivation. Covariates were not included in the calculation as any difference in age or gender could be important for the composition of the clusters and thus controlling for these covariates was undesirable. As can be seen in Appendix D, constituting dimensions explained 55 % of variance or more.

A Chi-squared test was performed to investigate if specific integration designs were associated with specific motivational profiles for RQ2, and a second MANOVA was conducted to discern if student's psychological needs were satisfied and frustrated differently between the different MOOC integration designs for RQ3. This was followed by post-hoc tests.

All analyses were carried out in IBM SPSS statistics 25, except for the Variance Ration Criterion calculations, which were completed in Microsoft Excel.

2.6. Ethical considerations

This study was approved by the Educational Research Review Board (ERRB) of X. It was conducted according to the Dutch General Data Protection Regulation (AVG). Data was anonymized and participants had the right and option to audit the way their data was stored. Participants signed an informed consent form and were aware they were able to withdraw at any moment without consequence. Participants were not offered compensation for partaking, nor were they disadvantaged in any way.

3. Results

A total of 272 participants filled out the questionnaire, 19 (95 %), 240 (67 %) and 13 (48 %) joined from integration design A, B and C, respectively. Mean age was 19.69 (stdev.= 1.416, data missing from 13 students) and 66,9 % were female versus 29,4 % male (data missing from 10 students). In total, 260 students from Leiden University participated, in integration designs A, B and C, and 12 students from other universities in Europe and Asia participated, in integration design A and C. To better understand motivation of students in MOOC integration designs and the factors that may influence this motivation, three research questions were posed. Results are presented in three sections, which relate to these research questions, respectively.

3.1. Typology of student motivation for formal MOOC learning

In Table 2 and Fig. 5, we have summarized the six motivation types based on the three underlying motivation dimensions. The K-means clustering algorithm revealed six types of motivation profiles: Students that are 1) Highly self-determined, who are regulated mostly by their autonomous motivation, 9,9 % (n = 26); 2) Self-determined, who are regulated by their autonomous motivation similarly, but with more emphasis on the other forms of motivation, 14,4 % (n = 38); 3) Grade hunting or CV building, who are regulated by all three types of motivation, with the highest amount of positive image motivation of all clusters, 23,6 % (n = 62); 4) Moderately trusting, who are regulated mostly by their autonomous motivation and instructor trusting motivation, but who have a moderate quantity of motivation, 13,7 % (n = 36); 5) Highly trusting, who also are regulated mostly by their autonomous motivation and instructor trusting motivation, but who have a high-quantity of motivation, 24,7 % (n = 65); and 6) Extremely trusting, who are regulated mostly by their autonomous motivation and instructor trusting motivation, but who have an extreme quantity of motivation, 13,7 % (n = 36).

Table 2
The six extracted clusters with mean scores and standard deviations of the constituting dimensions.

	Highly self-directed $n = 26$ (9,9 %)	Self-directed $n = 38$ (14,4 %)	Grade Hunters $n = 62$ (23,6 %)	Moderately trusting $n = 36$ (13,7 %)	Highly trusting $n = 65$ (24,7 %)	Extremely trusting $n = 36$ (13,7 %)
Constituting dimension						
Autonomous motivation	$5{,}73_a$ (0,51)	$5{,}72_a$ (0,64)	$5{,}00_b$ (0,65)	$3{,}74_c$ (0,71)	$4{,}74_b$ (0,72)	$6{,}06_a$ (0,47)
Instructor trusting motivation	$2{,}70_a$ (0,89)	$3{,}87_b$ (0,38)	$5{,}00_c$ (0,68)	$3{,}17_a$ (0,81)	$4{,}80_c$ (0,55)	$5{,}60_d$ (0,54)
Positive image motivation	$1{,}79_a$ (0,65)	$3{,}30_b$ (0,47)	$4{,}24_c$ (0,60)	$1{,}95_a$ (0,69)	$2{,}11_a$ (0,64)	$2{,}97_b$ (0,73)

Note. Cluster means are significantly different if they have different a, b, c and d subscripts.

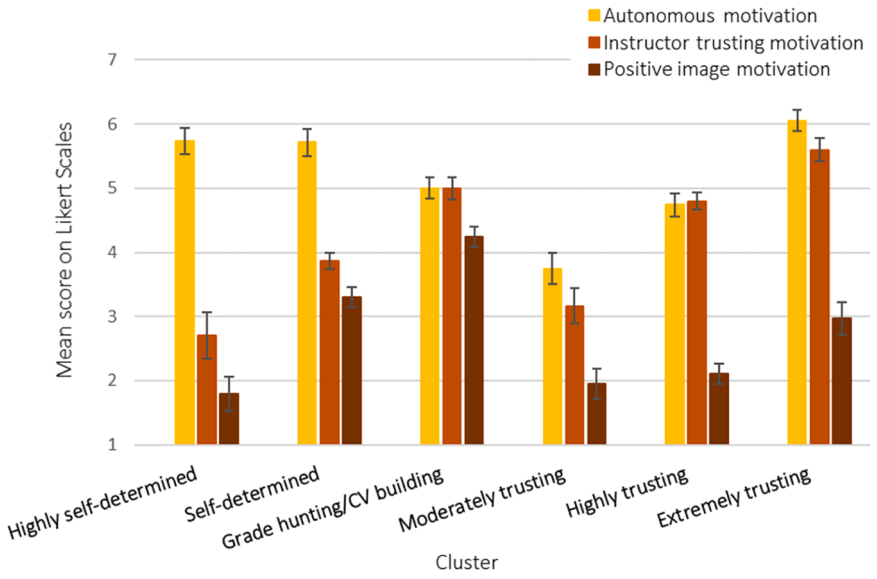

Fig. 5. Motivation profiles composed of distinct combinations of the three motivation types, including 95 % confidence intervals.

3.2. Relation between integration designs and motivation profiles

In Table 3 and Fig. 6, we have summarized the counts, expected counts and proportions of the six motivation types per MOOC integration design. All profiles were present in integration design B, with the majority of students (57 %) moderately, highly or extremely trusting, a quarter grade hunting or CV building and a minority (18 %) was (highly) self-determined. In integration design A only the Highly trusting profile was missing, and 75 % of the students had a Self-determined motivation profile, of whom the minority was Highly self-determined. Finally, in integration design C the moderately and extremely trusting profiles were not present and over three quarters of students had a Self-determined motivation profile, of whom the majority was Highly self-determined.

Table 3
Counts and expected counts of students with a specific motivation profile in each MOOC integration design.

		Integration design		Total	
		LOTS	MOD	Hons	
Highly self-determined	Count	4	15	7	26
	Expected Count	1,6	23,1	1,3	26
Self-determined	Count	8	27	3	38
	Expected Count	2,3	33,8	1,9	38
Grade hunters / CV builders	Count	2	58	2	62
	Expected Count	3,8	55,2	3,1	62
Moderately trusting	Count	1	35	0	36
	Expected Count	2,2	32	1,8	36
Highly trusting	Count	0	64	1	65
	Expected Count	4	57,8	3,2	65
Extremely trusting	Count	1	35	0	36
	Expected Count	2,2	32	1,8	36
Total	Count	16	234	13	263
	Expected Count	16	234	13	263

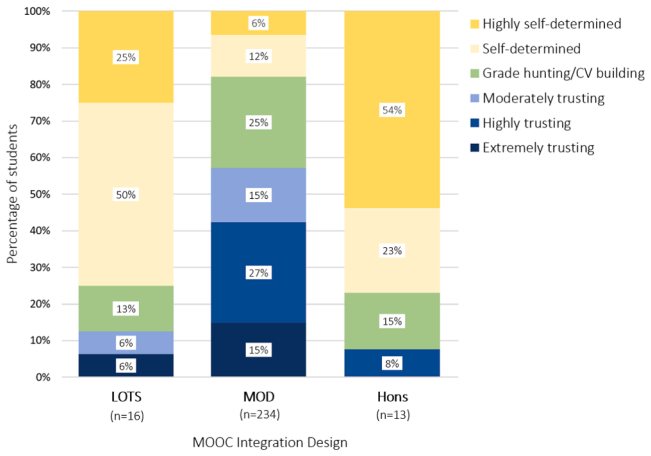

Fig. 6. Proportions of students with each motivation profile in three MOOC integration designs.

A chi-square test of independence was performed to examine the association between MOOC integration design and motivation profile. A cross tabulation of counts and expected counts for students in MOOC integration design and profiles can be found in Table 3. The relation

between these variables was significant, X^2 (10, N = 263) = 50.17 (Likelihood ratio), $p < .001$. Cramer's V was calculated as 66.7 % of the expected counts was less than 5. This resulted in an effect size of 0.340, signifying a weak to medium association between MOOC integration design and motivation profile.

3.3. Differences between integration designs regarding students' needs satisfaction and frustration

In Table 4 we have summarized mean scores and standard deviations of psychological need satisfaction and frustration for the three MOOC integration designs. To examine the differences in psychological need satisfaction and psychological need frustration between MOOC integration designs a MANOVA was performed. the Wilks's lambda was significant, $F(8496) = 6215$, $p < .001$; Wilks' $\Lambda = 0.826$, partial $\eta 2 = 0.091$, indicating that significant differences were found between MOOC integration designs for psychological need satisfaction and/or frustration.

Tukey's honestly significant difference post hoc test revealed that Relatedness-autonomy satisfaction scores were statistically significantly lower in integration design B (2,41 ± 0,68) versus A (2,86 ± 0,76, $p = .025$) and C (2,96 ± 0,45, $p = .012$), and that competence satisfaction scores were statistically significantly lower in integration design B (3,53 ± 0,57) versus A (3,97 ± 0,56, $p = .008$) and C (4,21 ± 0,45, $p < .001$). Relatedness-competence frustration scores were statistically significantly higher in integration design B (1,98 ± 0,59) versus A (1,54 ± 0,40, $p = 0.010$) and C (1,52 ± 0,42, $p = .014$), and autonomy frustration scores were also statistically significantly higher in integration design B (2,95 ± 0,77) versus C (2,19 ± 0,63, $p = .002$) but not A (2,52 ± 0,86). Scores from integration design A and C did not statistically differ significantly for any of the psychological needs. Overall, MOD students scored lower on psychological need satisfaction and higher on psychological need frustration than LOTS and Hons students.

4. Discussion

In this study we found six distinct motivation profiles based on three forms of motivation: Self-determined students and highly self-determined students, grade hunters, and teacher trusters who are moderately, highly or extremely trusting. We also found proportions of motivation profiles to differ significantly between MOOC integration designs, and that MOOC integration designs satisfy and frustrate psychological needs significantly different.

4.1. Motivation in integrated MOOC learning versus non-formal MOOC learning

We found similar motivation components as previous MOOC research that investigated reasons for learning in MOOCS [21,24] while using a different instrument, however our findings deviate from prior findings in several ways.

First, we did not find the same diversity in motivation components for learning in a MOOC as for example Kizilcec and Schneider [21] or Luik et al. [24]. It is possible that more motivation components might have surfaced with a different instrument.

Second, though our motivation components are similar to some of the components that non-formal MOOC learner profiles were based upon [32], the profiles are not. Specifically, our component autonomous motivation could be linked to Luik and Lepp's *interest in the course,* and positive image motivation could be linked to Luik and Lepp's *usefulness related to certification* and *social influence* based on similarity in items for these scales. However, the cluster solutions are not similar: the profile with the lowest score for *interest in the course* from Luik & Lepp [32] had a mean 7-point Likert scale score of 5.7 while in our profiles five out of six profiles have mean 7-point Likert scale scores for autonomous motivation of 5.73 or lower. Similarly, we found one cluster to peak (mean score 4.24) in positive image motivation, while Luik & Lepp [32] found one profile to dip (mean score 4.1) in *usefulness related to certification* and *social influence*.

Finally, [21] found that in 57 % of the non-formal MOOCs they investigated, learners said to be motivated by a prestigious university or professor to join the course. From their study it was unclear however to what extent this factor played a role. We have found instructor trusting motivation to play a major role in cluster formation in integrated MOOCs, with some profiles emphasizing the role of the instructor in motivation in relation to other factors.

Thus, motivation in integrated MOOC learning and non-formal MOOC learning seems to be measurable with similar factors, however previous and current results show that component scores and learner motivation profiles differ between non-formal and formal MOOC learning. Specifically, in integrated MOOC learning, autonomous motivation seems lower, positive image motivation seems more condensed to one profile, and instructor trusting motivation seems more prevalent. This is in line with earlier findings regarding intrinsic motivation and motivation to earn a certificate in university-affiliated students in MOOCs [39,40].

4.2. Motivation profiles in different integrated MOOC learning designs

Within integrated MOOC learning, we found motivation to learn to be context dependent as well. Different MOOC integration designs related to different psychological need satisfaction and frustration and also to different (proportions of) motivation profiles per design. Predictably the two designs that were less obligatory, A and C, had substantially larger proportions of self-determined students and better scores for psychological need satisfaction and psychological need frustration. The difference between design A and C in the amount of highly self-determined students could stem from the fact that in design C the MOOC was voluntary in an extracurricular program and A was compulsory in an extracurricular program. In addition, as these courses were for credit but extracurricular, we are not surprised to see CV-builders are also similarly present in design A and C. The most deviant design in terms of MOOC integration choices, design B, is also the most deviant in proportions of present profiles.

Notably, many students in this obligatory MOOC design are teacher trusters, with varying quantity of motivation. We believe, informed by a qualitative study in the same cohort (Authors, *submitted*), that students in this case acquiesce to what is expected of them. They do not study in the course out of interest per se but will have to complete it to progress in their studies and thus they revert to being 'led' by the teacher, 'who probably knows best'. This resonates with findings from Gupta and Maurya [58], who described that although the students in their study were only asked by their university teacher to join a MOOC, coercive pressure (e.g. pressure by the teacher) was of great influence on

Table 4
Mean scores and standard deviations of psychological need satisfaction and frustration for the three MOOC integration designs.

	LOTS	MOD	Hons
Psychological need satisfaction and frustration	n = 16 (6,3 %)	n = 225 (88,6 %)	n = 13 (5,1 %)
Satisfaction of			
Relatedness-autonomy	$2,86_b$ (0,76)	$2,41_a$ (0,68)	$2,96_b$ (0,45)
Competence	$3,97_b$ (0,56)	$3,53_a$ (0,57)	$4,21_b$ (0,45)
Frustration of			
Relatedness-competence	$1,54_b$ (0,40)	$1,98_a$ (0,59)	$1,52_b$ (0,42)
Autonomy	$2,52_{a,b}$ (0,86)	$2,95_a$ (0,77)	$2,19_b$ (0,63)

Note. MOOC integration design means are significantly different if they have different a and b subscripts.

intentions to adopt and complete a MOOC. This trust in the teacher also fits Vygotski's *Zone of Proximal Development* where the teacher is the designated 'more knowledgeable other' [63]. In addition, it resonates with the *Social Cognitive Path to Self-Regulatory Skills* as postulated by Zimmerman and Kitsantas [64], describing a gradual transference of self-regulated learning skills and agency from the teacher to the learner.

Our sample consists of undergraduate students only, however we found differences in the amount of teacher trusters between designs. Our current study cannot explain this difference; however we see possible explanations in two directions: 1) individual differences in self-regulated learning skills and learner maturity exist, and more advanced students self-select in voluntary MOOC integration designs; and 2) the design in which a MOOC is offered scaffolds a specific role for the teacher and the student. We expect both factors to play a role.

4.3. Psychological need satisfaction and frustration in different integrated MOOC learning designs

Design B differed significantly from design A and C for psychological need satisfaction and frustration. Self-selection might play a major role here. Specifically, higher scores for competence satisfaction and lower scores for relatedness-competence frustration in design A and C, might be explained by self-selection. Students that feel competent and or have high self-efficacy to learn in MOOCs, might be more prone to seeking voluntary extracurricular study credit in that form [65]. Similarly, to us, it seems only logical that autonomy frustration scores increase in more obligatory designs. If a self-selection effect is indeed in place, specifically obligatory designs are in need of competence and autonomy support [66].

Another important factor for psychological need satisfaction, might be the emphasis that is placed on the MOOC in the larger MOOC integration design. Our analyses revealed that items from relatedness and autonomy satisfaction loaded together and that students in design B scored significantly lower on this component. Looking at the items for this component (see Appendix C), we believe they might portray a feeling of 'belonging to or fitting into the (online) course', previously described by Goodenow [67] as a combination of feelings of relatedness or belonging to other people in the course and respect for autonomous choices. In this regard, we believe the difference in online/f2f ratio might play a role, as in integration design B the MOOC is only a small portion of an extensive face to face course. Peacock et al. [68] described that for a sense of belonging to an online course, engagement, the culture of learning and support are important themes. In our study, especially design B might not have had enough time or emphasis on the MOOC to develop real engagement or an online learning culture.

4.4. Future research, practical implications and limitations

While we found significant differences in motivation profiles between integration designs, in this study we can only speculate as to why these differences occur. In researching what works when in MOOC integration, many contextual variables are present [58], including the topic or discipline of the MOOC, the choices in the integration design and the instructional design or teaching mode profile of the final blend, to name a few. In this study we investigated three already existing MOOC integration designs with the same MOOC, and so our authentic designs do not differ in topic or discipline, but they do on various other variables. The next step is to compare integration designs that differ on only one variable at a time. In this regard, our study can inform future research efforts by suggesting which variable to start with, how to organise research efforts and finally, highlighting the need for fitting instrumentation.

First, we propose to investigate the role of the degree of obligation in MOOC integration designs, as it may lead to self-selection of students or changes in motivation during the course. This means that student-characteristics related to motivation, for example goal-orientation, self-efficacy, and self-regulated learning skills, should be measured, while also recording whether students are obligated to study in the integration design, or whether they joined on their own initiative. In addition, motivation should be measured at multiple time points to reveal if student characteristics, the design of the course, or an interplay are responsible for differences. In this case, integration designs will have to be created specifically to facilitate research, whereas most MOOC integration designs, like ours, were created to facilitate education practice. In addition, all other features in the design should be controlled for such as the MOOC, integrated teaching mode profile, level of education, ratio of online versus face-to-face teaching, level of contact with other online learners in the MOOC and preferably the teachers, institution and even course.

Second, all other variables in the integration design need investigation, also by comparing them side by side with only one variable changed. This is a major undertaking, and we deem it highly unlikely that all variables can be investigated in one single setting. Therefore, we propose that for all research into MOOC integration designs, design features i.e., choices for at least all the variables above, should be explicated, as to ease efforts for the meta-analysis that is needed to answer the overarching question of 'what works when'.

Finally, as we aimed to measure motivation in terms of autonomous and controlled motivation as previous studies in formal education, but found components that resemble motivation previously described for MOOC learning, optimal instrumentation for measuring motivation in integrated MOOC settings should be studied.

The desired motivation profile is that of the highly self-determined student, as previously it has been shown that high-quality motivation is related to better academic achievement and high autonomous motivation is related to better learning strategies, well-being and enjoyment [41]. Our study showed that in MOOC integration designs similar to A and C, not much support may be needed. However, in courses similar to integration design B, psychological need satisfaction and frustration could be improved. In this regard, it is advisable to monitor motivation when integrating a MOOC obligatorily and take precautions to support motivation beforehand. This can be done by integrating MOOCs that are already designed with improving motivation in mind, for example with game elements and personalised designs [69], earning badges for completed assignments [70], improved content, accessibility and interactivity [71], and specific support for self-regulated learning skills [72]. In addition support of feelings of autonomy, relatedness and competence in the final MOOC integration design can be realised through relatively small interventions [44].

Three limitations need to be mentioned. First, generalisability to other MOOC integration designs and contexts needs to be examined as our findings are, per design of the study, highly context specific. Second, in this study participation rates of 95 %, 67 %, and 48 % were obtained for integration designs A, B and C, respectively. As the 'missing' data in this study could be missing due to low motivation, which is the measured construct in this study, we gather data is missing possibly not at random. As a group of students might in fact have not responded because of low motivation, we have to take into account a possible representation bias. This could mean our results present a slightly more positive view on motivation to learn in integrated MOOCs than it in reality is. Mean scores for motivation components could thus be lower, or an extra very low motivation profile could be missing. Especially for integration design C it could mean that the proportion of self-determined students is in fact smaller than we have found. As we did find a lower quantity motivation profile among the 'Teacher trusters' we do believe the findings are representative and implications are highly valuable for future research and practice. Third, in absolute numbers, integration design A and C yielded few participants, which is an accurate representation of the number of students that participate each year. Further, cluster formation was based on the compiled number of students for RQ1, and a significant correlation and significant differences could be detected for RQ2 and RQ3, respectively.

5. Conclusions

In integrated MOOC learning students are motivated by autonomous motivation, trust in their instructor and the image others have of them, which had not been reported before. From these components six different motivation profiles presented: highly self-determined students, self-determined students, grade hunters or CV builder, and moderately, highly and extremely trusting students. Motivation components in integrated MOOC learning are similar to motivation components in non-formal MOOC learning, however motivation profiles are not. Finally, motivation to learn in integrated MOOCs is dependent of the MOOC integration design, and most likely supported by psychological need satisfaction and frustration. However, what and how design choices are most influential needs to be studied further.

This study is the first to characterise motivation to learn in formally integrated MOOCs, and the first to compare integration designs based on motivation. Contributions to theory include a focus on specific motivation factors for students learning in integrated MOOCs, a typology of motivation of students in these contexts, confirmation of a connection between integration design and motivation profile, and finally indications and directions for further research into designing for and fostering desirable profiles. Contributions to practice include directions for monitoring motivation when integrating MOOCs, and supporting more obligatory designs.

Authors' contributions

RH drafted a first version of the research proposal and design, which was refined by discussions with all authors. Data collection was organised by RH and executed by PdJ. Data analyses were executed by RH and regularly discussed with WA. All authors were involved in interpreting results and formulating conclusions. For interpretation the Medical Education Research group of the LUMC was also consulted during a meeting. RH drafted the first version of the article which was refined to the final article by iterations of comments from all authors.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The anonymized datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

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We would like to thank the members of the Medical Education research group in the LUMC for their contribution to our interpretation of the data.

Appendix A. Information letter and informed consent form

Dear student,

We want to ask you to participate in this educational study. In this study we investigate motivation and independent (or self-regulated) online learning skills of students that learn in Massive Open Online Courses (MOOCs) for their medical studies. We ask all medical students of the Leiden University Medical Center that have enrolled in one of the following courses to participate in this research: *Mechanisms of Disease (MOD),* Leiden Oxford *Transplantation Summer school (LOTS), and students that participate in the Virtual Exchange or Honors program (Hons)*. Your participation will have no consequences for your study progress and results will only be used for research purposes. We would ask you to read the following points carefully and if you agree to participate in the study, provide the consent form with a date and your confirmed consent.

Purpose of the investigation

The purpose of this research is to 1) compare motivation between different courses that use the MOOC, and 2) see how motivation and independent learning are related when learning in a MOOC. Results will inform future MOOC use in the Leiden University Medical Center and other universities.

Conducting the investigation

Participation consists of filling in two questionnaires (Q1 and Q2), one before starting the MOOC and one after you have finished learning in the MOOC. Each will take approximately 15–20 min. A small number of the participants will be asked to also partake in an interview to deepen understanding of the results. Students that are approached for the interview study will receive additional information after results of the questionnaires have been analyzed. You will receive Q1 via email, and Q2 will be distributed after a lecture (LOTS), before a workgroup, or after an exam (MOD), and via email (Hons, and all previously unreached students of LOTS and MOD).

What is expected of you?

If you participate in the study, you do not have to make specific preparations.

Advantages and disadvantages and possible risks

Your participation is entirely voluntary. If you decide not to participate or withdraw at any time during the study, you do not have to give a reason. If you withdraw, we will not include the collected data in our investigation and destroy it. Participating or not participating in the study will in no way affect your further study progress negatively. If you decide to participate, it is greatly appreciated by us as it will provide useful information for future use of MOOCs in medical education. Your participation in this research can offer you new insights into your motivation and self-regulated learning skills if you wish to see your analyzed results, which can ultimately benefit your academic performance and enjoyment of learning. There are no risks associated with participating in this study. Confidentiality and privacy are guaranteed.

What happens with your data?

The data will be stored encrypted and stored in a protected folder on a protected Leiden University Medical Center server. Coded means that it cannot be directly traced back to you. Only the principal investigator Renée Hendriks (PhD candidate) or her possible successor, have access to the directly traceable data. The other researchers involved only have access to the coded data. You have the right to see the way in which your data is stored.

Review committee

Approval for this research has been obtained from the Educational Research Review Board (ERRB) of the Leiden University Medical Center.

Contact information

If you have any questions about the research or your participation, you can contact the principal investigator.

Many thanks in advance, on behalf of the research team,

Renée Hendriks

Peter de Jong

Wilfried Admiraal

Marlies Reinders

CONSENT

Please select your choice below. You may print or request a copy of this consent form for your records. Selecting the "Agree" button indicates that:

- You have read the above information
- You voluntarily agree to participate
- You give permission to use your data for the purposes stated in the information letter

☐ Agree

☐ Disagree

Name: _____, Date: _/_/_

To be completed by researcher:

I hereby declare that I have sufficiently informed this participant about the aforementioned study. If information becomes known during the investigation that could influence the consent of the participant, I will inform him / her in a timely manner in a manner that ensures that the information has reached the participant.

Researcher's name: Renée Hendriks

Signature: Date: _ / _ / _

Appendix B. Component loadings of three types of motivation for all items

Component				$N = 265$, sample size threshold for loading significance =0.35
	Autonomous motivation	Instructor trusting motivation	Positive image motivation	
Item #	*1*	*2*	*3*	*Item*
T2AQ9	0,859			The reason that I worked to expand my knowledge of transplantation in the MOOC is: 9. Because it is interesting to learn more about the nature of transplantation medicine.
T2AQ4	0,835			I have participated actively in the MOOC: 4. Because a solid understanding of transplantation medicine is important to my intellectual growth.
T2AQ1	0,816			I have participated actively in the MOOC: 1. Because I feel like it is a good way to improve my understanding of the material.
T2AQ10	0,806			The reason that I worked to expand my knowledge of transplantation in the MOOC is: 10. Because it is a challenge to really understand how to solve transplantation problems.
T2AQ3	0,580			I have participated actively in the MOOC: 3. Because I would feel proud of myself if I did well in the course.
T2AQ7		0,819		I have followed the instructor's suggestions for studying transplantation medicine online: 7. Because it is easier to follow his/her suggestions than come up with my own study strategies.
T2AQ8		0,781		I have followed the instructor's suggestions for studying transplantation medicine online: 8. Because he/she seems to have insight about how best to learn the material.
T2AQ6		0,668		I have followed the instructor's suggestions for studying transplantation medicine online: 6. Because I am worried that I am not going to perform well in the course.
T2AQ5		0,595		I have followed the instructor's suggestions for studying transplantation medicine online: 5. Because I would get a bad grade if I didn't do what he/she suggests.
T2AQ11			0,768	The reason that I worked to expand my knowledge of transplantation in the MOOC is: 11. Because a good grade in the MOOC will look positive on my record.
T2AQ12			0,768	The reason that I worked to expand my knowledge of transplantation in the MOOC is: 12. Because I want others to see that I am intelligent.
T2AQ2			0,640	I have participated actively in the MOOC: 2. Because others might think badly of me if I didn't.

Appendix C. Component loadings of three and two subscales of psychological need satisfaction and frustration for all items

Component				$N = 259$, sample size threshold for loading significance = 0.35
	Relatedness-autonomy satisfaction	Competence satisfaction	Autonomy satisfaction	
Item #	*1*	*2*	*3*	*Item*
T2CQ15	0,898			I feel close and connected with other people in the MOOC who are important to me.
T2CQ9	0,767			I feel connected with people in the MOOC who care for me, and for whom I care.
T2CQ21	0,760			I experience a warm feeling with the people I spend time with in the MOOC.
T2CQ3	0,667			I feel that the people in the MOOC I care about also care about me.

(*continued on next page*)

(*continued*)

Component				$N = 259$, sample size threshold for loading significance = 0.35
	Relatedness-autonomy satisfaction	Competence satisfaction	Autonomy satisfaction	
T2CQ13	0,589			I feel my choices in the MOOC express who I really am.
T2CQ7	0,576			I feel that my decisions in the MOOC reflect what I really want.
T2CQ5		0,851		I feel confident that I can do things well in the MOOC.
T2CQ17		0,783		I feel competent to achieve my goals in the MOOC.
T2CQ11		0,773		I feel capable at what I do in the MOOC.
T2CQ23		0,698		I feel I can successfully complete difficult tasks in the MOOC.
T2CQ1			0,871	I feel a sense of choice and freedom in the things I undertake in the MOOC.
T2CQ19			0,489	I feel I have been doing what really interests me in the MOOC.

	Component		$N = 262$, sample size threshold for loading significance = 0.35
	Relatedness-competence frustration	Autonomy frustration	
Item #	*4*	*5*	*Item*
T2CQ24	0,796		I feel like a failure because of the mistakes I make in the MOOC.
T2CQ18	0,743		I feel insecure about my abilities in the MOOC.
T2CQ10	0,711		I feel that people who are important to me in the MOOC are cold and distant towards me.
T2CQ12	0,705		I feel disappointed with many of my performances in the MOOC.
T2CQ16	0,697		I have the impression that people I spend time with in the MOOC dislike me.
T2CQ4	0,613		I feel excluded from the group I want to belong to in the MOOC.
T2CQ6	0,608		I have serious doubts about whether I can do things well in the MOOC.
T2CQ2		0,826	Most of the things I do in the MOOC feel like "I have to".
T2CQ8		0,787	I feel forced to do many things in the MOOC I wouldn't choose to do.
T2CQ14		0,770	I feel pressured to do too many things in the MOOC.
T2CQ20		0,735	My daily activities in the MOOC feel like a chain of obligations.

Appendix D. Explained variance of cluster solution by constituting dimensions

Constituting dimension	$F(5, 263)$	η^2
Autonomous motivation	64,09***	0,55
Instructor trusting motivation	109,72***	0,68
Positive image motivation	111,45***	0,68
Quantity of motivation	149,057***	0,74
Quality of motivation A	56,05***	0,52
Quality of motivation B	102,15***	0,67

Note. Quality of motivation A is calculated as Autonomous motivation and Instructor trusting motivation combined minus Positive image motivation. Quality of motivation B is calculated as Autonomous motivation minus Instructor trusting motivation and Positive image motivation. As Instructor trusting motivation can consist of both autonomous and controlled forms of regulation, two types of quality of motivation we calculated

***$p<.001$

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