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A computer-supported collaborative learning environment in medical education: The importance for educators to consider medical students' motivation

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ABSTRACT

Objective: In a social-constructivist learning approach, students are considered as active participants who construct knowledge collaboratively. When medical students are dispersed among different hospitals during their elective they are often not able to learn collaboratively. A computer-supported collaborative learning (CSCL) environment could be suitable to medical students to efficiently organize collaborative learning activities. The success of CSCL depends on students' motivation to participate in the online discourse. Although medical students are commonly considered to be highly intrinsically motivated, the educational approach in medical education is still externally regulated and highly controlled. Therefore, the aim of the present study was to explore whether an autonomous CSCL environment is more suitable to support an intrinsically motivated medical student and whether a controlled CSCL environment is more suitable to support an extrinsically motivated medical student.

Methods: In a controlled study design, 52 medical students participated in a discussion task on a forum in either an autonomous or a controlled CSCL environment. Students' perceptions were asked on their competence to solve the task, on their motivational growth, and on the autonomy support of the learning environment.

Results: Twenty-nine students (56%) were considered as extrinsically motivated. Students' pre- and post-scores showed significant differences on their motivational growth in either the autonomous or the controlled CSCL environment.

Conclusion: It is important for educators to consider students' motivation when planning and delivering education by using a CSCL learning environment. After conducting a scripted task in a CSCL environment, specifically designed to their motivation, extrinsically as well as intrinsically motivated medical students show motivational growth.

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Introduction

In a social-constructivist learning approach, students are considered as active participants who construct knowledge collaboratively [1]. Collaborative learning is regarded as an essential component of education and it stimulates students' reflection and critical thinking, deeper-level learning, and shared understanding [2–5]. When medical students are dispersed among different hospitals during their elective, they are often not able to learn collaboratively [6–8]. In order to achieve meaningful and effective learning, these students can profit from collaborative learning activities by an online learning environment. A computer-supported collaborative learning (CSCL) environment could be suitable to medical students to efficiently organize collaborative learning activities. CSCL is a pedagogical approach where learning happens through interaction between students by using a computer [9]. Students can share their work and provide formative peer feedback on each other's work to construct knowledge by using an online structured asynchronous discussion forum on a CSCL environment [3,4,6,7]. The success of CSCL depends, amongst other things, on the intensity of students' online

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discourse during the collaborative activity [10–12]. One of the determinants explaining the intensity of students' discourse is the motivation of the individual student to participate in a CSCL environment [12–15]. Although medical students are commonly considered to be highly intrinsically motivated [16], the educational approach in medical education is still externally regulated and highly controlled. Such a learning environment largely focuses on cognitive processing in which students have to respond within a context of interlocking rewards and relationships, incentives, and barriers [16]. Little is known on how teachers and educational designers could use a specific learning environment to fit medical students' motivation. A controlled learning environment could be suitable to extrinsically motivated medical student by providing them with structure, and a high amount of guidance and scaffolding [17]. Intrinsically motivated medical students could possibly profit more from an autonomous learning environment in which they have to determine when, where, and how to learn. Such an autonomous learning environment is characterized by a limited amount of external structure, and less guidance and scaffolding [18]. Therefore, the aim of the present study was to explore whether an autonomous CSCL environment is more suitable to support an intrinsically motivated medical student and whether a controlled CSCL environment is more suitable to support an extrinsically motivated medical student.

Research questions

- What is a medical students' perceived competence to solve a task on a discussion forum in a controlled or an autonomous CSCL environment?
- Does an autonomous CSCL environment support an intrinsically motivated medical student when conducting a task?
- Does a controlled CSCL environment support an extrinsic motivated medical student when conducting a task?
- What is a medical students' perception on the autonomy support of either a controlled or an autonomous CSCL environment after solving a task?

Materials and Methods

Participants and task

Fifty-two medical students from the study of clinical-investigator of the Faculty of Health, Medicine and Life Sciences at the Maastricht University, The Netherlands, participated in this study that was conducted in the period spanning June 2013–September 2013 and June 2014–September 2014. The clinical-investigator program is a 4-year graduate entry medical program [19]. In addition to their medical degree, these students also receive a MSc in clinical research. All students gave informed consent before the start of the study. The amount of students represents about 20% of the total amount of medical students in that academic year. In preparation for a clinical research elective in the last year, each individual master student had to design a research project and had to autonomously write a fully-detailed research protocol. Such a protocol includes the following four topics, each consisting of specific subtopics: (1) Introduction and background; "problem definition," "literature references," "previous study results," and "relevance of the present study," (2) Hypothesis and research question(s); "hypothesis," and "research question(s)," (3) Research population; "inclusion criteria," "patient selection," "power and sample size," and "exclusion criteria," (4) Research design; "methods," "design," "data-analysis," "statistics," "selection procedure," and "intervention(s)."

In the earlier years of this program, students had practiced their skills in either writing parts of a research protocol individually or prepared a whole research protocol in cooperation with peers.

Study design

In a controlled study design, all participants were asked to solve the task in a discussion group of a CSCL environment. Before and after the task, students were asked to fill in several questionnaires on their motivation. According to their motivation, students were assigned to a discussion group consisting of three to four students with a similar motivation.

CSCL environment

The motivational theory of self-determination (SDT) distinguishes different types of motivation: "intrinsic motivation," "extrinsic motivation," and "amotivation," according to the degree of students' self-determination [20–23]. According to the SDT, motivation is strongly influenced by a social environment with three universal, basic psychological needs, i.e., feeling of "Competence" (effectively interacting with the environment to yield desired outcomes), sense of "Autonomy" (a sense

of volitional control), and sense of "Relatedness" (feeling connected with significant others) [20,21]. Based on these three psychological needs, an autonomous CSCL environment and a controlled CSCL environment were designed [17,20,22–28]. In the autonomous CSCL environment, students are provided with freedom, volition, and responsibility over their learning process. In the controlled CSCL environment, students are provided with high structure and guidance in their learning process. Table 1 shows the characteristics of both CSCL environments.

Students' instruction

All students received instruction by a script that provided them with clear information concerning the task [30]. The task was executed in the learning management system Blackboard©. Three consecutive phases were described in the script. The first phase involved students' preparation on the task; sending their individually written research protocol to a "drop-box" in the CSCL environment, and reading their peers' protocols.

The second phase was related to the actual review of students' protocol. In this phase, students were engaged in an asynchronous CSCL forum discussion on both the strong and weak points of each other's protocols. The third phase involved protocol revision based on peer feedback provided during the discussion; and submission of their final written protocol to an expert (teacher) for feedback and grading.

Measurement instruments and statistical analysis

Dividing students into discussion groups

The relative autonomy index (RAI) was used to express students' motivational profile in a validated and reliable manner [21,27]. The RAI operationalizes individual students' level of autonomous motivation, relative to the level of controlled motivation or a-motivation. A students' individual RAI-score can be calculated by the sum of the weighted subscales of the academic motivation scale (AMS) [18,19,21,27,31–34], see Table 2. An overall group median of the RAI-scores was calculated by using all students RAI-scores [27,35–37]. Students with a RAI-score above the overall group median were placed into the cohort

Table 1. Characteristics of autonomous and controlled learning environment designed by three psychological needs.

Psychological need	Autonomous CSCL environment	Controlled CSCL environment
Competence	Each individual master student had to discuss a fully-detailed research protocol, where students were free to whether or not follow the four predefined topics (including subtopics) of a research protocol [22]	Each individual master student had to discuss a fully-detailed research protocol according to the pre-defined structure of writing a research protocol, covering the four predefined topics (including subtopics) [22]
Autonomy	Students are free to plan their own learning process and conduct the task by self-formulated learning goals [16,22,26,27]	Students have to conduct the task within a preformatted time schedule and conduct a task by learning goals as formulated in the script [22,26]
Relatedness	Students are free to choose any communication tool provided on the CSCL environment to solve their task [22,27,29,31–33]	Students mandatorily have to use the prescribed tools of the CSCL environment only to solve the task [22,24,29,31–33]

Table 2. Seven subscales of the AMS with their definition.

Motivation	AMS subscales	Subscale definition
Intrinsic motivation	1. to know	learning for the satisfaction and pleasure to understand something new
	2. toward accomplishment	learning for experiencing satisfaction and pleasure to accomplish something
	3. to experience the stimulation	learning to experience stimulation
Extrinsic motivation	4. identified	behavior is internally regulated in a self-determined way because one has decided to do it
	5. introjected	doing something because one pressures oneself to do it through rewards or by others' constraints
	6. external regulation	doing something because one is pressured through rewards or by others' constraints
a-motivation	7. a-motivation	the absence of regulation, either externally directed or internally

of intrinsically motivated students and were divided into one of the discussion groups of the autonomous CSCL environment. Students with a RAI-score below the overall group median were placed into the cohort of extrinsically motivated students and were divided into one of the discussion groups of the controlled CSCL environment.

Students' perception on the competence to solve a task

The perceived competence scale (PCS) [22] was conducted to investigate students' competence to solve their task. The PCS consists of four items which each can be scored on a Likert scale from 1 to 7 (1 = not at all true, 4 is somewhat true, and 7 = very true). Descriptive statistics [mean, ±standard deviation of the *mean* (SD)] on students' pre-PCS-scores and post-PCS-scores were calculated. Pre-PCS-scores and post-PCS-scores were compared by a Wilcoxon Signed Ranks test in either the autonomous or the controlled CSCL environment.

Students' motivation

Students' overall motivation as well as subtle changes in motivation was investigated. Students' overall motivational growth was measured by the AMS consisting of seven subscales [22]. Each of these subscales contains four items. Each item represents a possible reason for a student to attend their study, as presented in Table 2. All items are scored on a seven-point Likert scale (1 = corresponds not at all, 4 = corresponds moderately, and 7 = corresponds exactly). Descriptive statistics (mean; ±SD) on students' pre-AMS-scores and post-AMS-scores were calculated. Pre-AMS-scores and post-AMS-scores were compared by a Wilcoxon Signed Ranks test in either the controlled or the autonomous CSCL environment.

Subtle changes in students' motivational growth were measured by the basic psychological needs scale (BPS) [22]. The BPS consists of three subscales: "Competence," represented by six items; "Autonomy," with seven items and "Relatedness," consisting of eight items. All items are scored on a seven-point Likert scale (1 not at all true, 4 = somewhat true, and 7 very true). Descriptive statistics (mean; **±**SD) on students' pre-BPS-scores and post-BPS-scores were calculated. Students' pre-BPS-scores and post-BPS-scores were compared by a Wilcoxon Signed Ranks test in either the controlled or the autonomous CSCL environment.

Students' perceived autonomy support of the learning environment

The Questionnaire for perceived autonomy support (PAS) [22] was used to score students' perceptions on the autonomy support of the learning environment after solving a task. The PAS consists of 15 items that can be scored by a Likert scale 1–7 (1 = strongly disagree, 4 = neutral, and 7 = strongly agree). Descriptive statistics (mean; **±**SD) on students' PAS-scores were calculated. Students' PAS-scores between the controlled and autonomous CSCL environment were compared by a Kruskal–Wallis one-way analysis of variance.

Results

Dividing students into discussion groups

Students' RAI showed a median score of 12.25. Out of the 52 participants, 29 students (56%; 13 male and 16 female) scored below the median RAI score and were considered as extrinsically motivated. The remaining 23 students (44%; 5 male and 18 female) scored above the median RAI score, these students were considered as intrinsically motivated. Dividing students into discussing groups resulted in nine discussion groups within a controlled CSCL environment and eight discussion groups within an autonomous CSCL environment, consisting of three to four students each.

Students' perception on the competence to solve the task

No differences were found on students' perceptions on their competence to solve a task between both the pre-PCS-score and the post-PCS-score of the controlled (pre: n = 29; post: n = 29) and the autonomous (pre: n = 23; post: n = 23) CSCL environment (Table 3).

Students' motivation

Students' overall motivational growth showed no differences between the pre-AMS-scores and post-AMS-scores in either the controlled (pre: n = 29; post: n = 22) or the autonomous (pre: n = 23; post: n = 17) CSCL environment (Table 3).

Subtle changes in students' motivational growth showed significant differences between the pre-BPS-scores and post-BPS-scores within the needs "Competence" and "Relatedness" of both the controlled (pre: n = 29; post: n = 22) and the autonomous (pre: n = 23; post: n = 17) CSCL environment. The need "Autonomy" showed nearly significant

difference between the pre-BPS-scores and post-BPS-scores of the controlled CSCL environment (Table 3).

Students' perceived autonomy support of the learning environment

No differences were found between students' PAS of the learning environment after the task in both the controlled and the autonomous CSCL environment (Table 4).

Discussion

The results of present study indicate that an autonomous CSCL environment specifically designed for intrinsically motivated medical students is suitable to support these students to execute a collaborative task. Furthermore, a controlled CSCL environment is suitable to execute a collaborative task by extrinsically motivated medical students.

Before task execution, both intrinsically and extrinsically motivated students showed positive perceptions on their competence to solve their task. Earlier research showed that a slight overestimation of students' competence was seen as a preference to solve a task, for it indicates that a student dares to attain the challenge of a task and consists in executing the task in case of a setback [38]. In present study, the post-PCS score of extrinsically motivated students showed slight decrease (−0.30) according to the pre-PCS, which could indicate this overestimation of students' competence. Previous research found that intrinsically motivated students start new tasks autonomously with full confidence and positive affect, despite of the challenges they encounter before starting the task [38,39]. The present study shows no differences in pre-PCS and post-PCS-scores by intrinsically motivated students (increase of 0.07) which confirms these earlier findings. These intrinsically motivated students show confidence on their competence to fulfill a task and this confidence is not influenced after conducting the task.

Medical students are commonly considered to be highly intrinsically motivated [16]. The present study shows an unexpected minority of students that were considered as intrinsically motivated; students with a RAI score above the group median. Former research showed that the common educational approach of a learning environment in medical education is still externally regulated and highly controlled [17]. After conducting a discussion with a scripted task in a CSCL environment, intrinsically as well as extrinsically motivated students showed a small, but not significant, motivational growth in their AMS-score. This could be an indication that an autonomous CSCL environment suits intrinsically motivated students well, and a controlled CSCL environment suits extrinsically motivated student. Exploring students' motivation more specifically by the use of the BPS, both intrinsically and extrinsically students showed a positive motivational growth on all three psychological needs. Two of these three needs showed a significant increase after the task: (1) feeling of "Competence" (effectively interacting

Table 3. Pre-post scores on the PCS, the AMS, and the BPS.

	Controlled CSCL environment			Autonomous CSCL environment		
	Pre-score mean (±SD)	Post-score mean (±SD)	*p*-value	Pre-score mean (±SD)	Post-score mean (±SD)	*p*-value
PCS	4.55 (1.07)	4.25 (1.42)	$p = 0.492$	4.91 (1.36)	4.98 (1.33)	$p = 0.722$
AMS	4.03 (0.56)	4.18 (0.65)	$p = 0.089$	4.37 (0.53)	4.54 (0.63)	$p = 0.196$
BPS						
Competence	4.50 (0.66)	5.19 (0.73)	$p = 0.023$*	4.92 (0.91)	5.57 (0.70)	$p = 0.020$*
Autonomy	4.46(0.71)	4.92 (0.79)	$p = 0.055$	4.78 (0.99)	5.06 (0.97)	$p = 0.269$
Relatedness	4.79 (0.81)	5.39 (0.76)	$p = 0.008$*	5.11 (0.95)	5.73 (0.60)	$p = 0.008$*

Table 4. Pre-post scores (mean; ± SD) of students' PAS of the learning environment.

PAS of the learning environment		
Controlled CSCL environment (*n* = 22)	Autonomous CSCL environment (*n* = 17)	
Post-score	Post-score	*p*-value
4.80 (1.09)	4.55 (0.84)	$p = 0.173$

with the social environment to yield desired outcomes) and (2) sense of "Relatedness" (feeling connected with significant others). The importance of these results are that extrinsically motivated students could possibly profit more from collaborating in a controlled learning environment than an in autonomous learning environment. Furthermore, intrinsically motivated students could possibly profit more from collaborating in an autonomous learning environment than in a controlled learning environment. These findings are in line with former research of Rienties et al. [18,37] describing that a controlled learning environment is suitable to extrinsic motivated students who need external structure, guidance and scaffolding which can positively influence students' engagement.

After their task, intrinsically motivated students showed positive perceptions on the autonomy support of the autonomous CSCL environment. Extrinsically motivated students showed an even higher perception score on the controlled design of a CSCL environment. Supporting students' competence is important to prevent students' a-motivation, and supports the internalization process of both extrinsic and intrinsic motivation by students [21,22].

The results of present study shows that when providing a specifically designed CSCL environment, intrinsically motivated students are supported by an autonomous CSCL environment as well as extrinsically motivated students are supported by a controlled CSCL environment.

Present study is not without limitations. First, in the present study there was no cross-over design; extrinsically motivated students did not conduct a task within an autonomous CSCL environment and intrinsically motivated students did not conduct a task within a controlled CSCL environment. Despite of this absence, it is believed that all students were randomized into the proper CSCL environment specifically designed on their motivation. A second limitation is that however extrinsically motivated students scored well on the supportive element of the controlled CSCL environment, the need of these students for even more scaffolding than delivered by a CSCL environment only cannot be excluded. It can be expected that these students still need the beneficial support of a teacher to prepare them on the task execution and to guide them during the task. A third limitation could be the group of participants, all from a specific cohort. The question here is whether the participating students are a proper resemblance of all medical students at the faculty. However, the present research shows that a difference in motivation between medical students exists, clearly not every medical student is intrinsically motivated.

Further research can be conducted on medical students' motivation. First, to explore the accuracy of our common believe that medical students are usually intrinsically motivated, and to monitor students' motivation and possible change during a period when they conduct several tasks. Second, further research is needed on the specific design of a CSCL environment that stimulates students' motivation to participate actively on a discussion forum of a CSCL environment. Third, research can be conducted on the kind of educational support needed by students, apart from of a task on a CSCL environment.

Conclusion

It is important for educators to consider students' motivation when planning and delivering education by the use of a CSCL learning environment.

After conducting a scripted task in a CSCL environment, specifically designed to their motivation, extrinsically as well as intrinsically motivated medical students show motivational growth on two psychological needs: Competence and Relatedness.

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