Group learning activities and perceived learning outcomes

De Hei, Miranda; Admiraal , Wilfried; Sjoer, Ellen; Strijbos, Jan-Willem

Published in:
Studies in Higher Education

DOI:
10.1080/03075079.2017.1327518

Publication date:
2018

Studies in Higher Education

ISSN: 0307-5079 (Print) 1470-174X (Online) Journal homepage: https://www.tandfonline.com/loi/cshe20

Group learning activities and perceived learning outcomes

Miranda De Hei, Wilfried Admiraal, Ellen Sjoer & Jan-Willem Strijbos

To cite this article: Miranda De Hei, Wilfried Admiraal, Ellen Sjoer & Jan-Willem Strijbos (2018) Group learning activities and perceived learning outcomes, Studies in Higher Education, 43:12, 2354-2370, DOI: 10.1080/03075079.2017.1327518

To link to this article: https://doi.org/10.1080/03075079.2017.1327518

STUDIES IN HIGHER EDUCATION
2018, VOL. 43, NO. 12, 2354–2370
https://doi.org/10.1080/03075079.2017.1327518

Routledge
Taylor & Francis Group

Group learning activities and perceived learning outcomes

Miranda De Hei[a], Wilfried Admiraal [b], Ellen Sjoer[c,d] and Jan-Willem Strijbos[e]

[a]Department of Teacher Education, The Hague University of Applied Sciences, The Hague, Netherlands; [b]Leiden University Graduate School of Teaching, Leiden University, Leiden, Netherlands; [c]Research Group Sustainable Talent Development, The Hague University of Applied Sciences, The Hague, Netherlands; [d]Faculty of Technology, Policy and Management, Delft University of Technology, Delft, Netherlands; [e]Department of Education and Educational Psychology, Ludwig-Maximilians-University Munich, Munich, Germany

ABSTRACT

Group learning activities (GLAs) are commonly used curriculum activities in teacher education. The aim of this study was to determine which components of GLAs students perceive as significant for their learning. Student teachers from six Dutch universities of applied sciences completed a survey about GLAs they participated in. Findings show that students' evaluations of task characteristics and group constellation are related to their perceived increase in domain knowledge. Furthermore task characteristics and guidance are related to students' perceived development as primary school teachers. Verbal interaction and engagement partially and fully mediate several relationships between GLA components and learning outcomes.

KEYWORDS

Group learning; collaborative learning; educational design; learning outcomes

1. Introduction

Collaborative learning can contribute to the acquisition of a variety of knowledge and skills, including higher order thinking skills and metacognitive skills (Johnson and Johnson 2009a), and to the development of prosocial behaviour such as empathy and helping others (e.g. Gillies, Ashman, and Terwel 2008). Collaborative learning in higher education is regularly implemented in higher education as group learning activities (GLAs). GLAs can be defined as curriculum activities, in which students work on a collaborative project during a time period longer than one lesson (De Hei et al. 2016b). In teacher education, the use of GLAs has additional goals. For example, teacher educators use GLAs to model how student teachers can facilitate collaborative learning in their classrooms as teachers in primary or secondary education. Furthermore, the future work setting of student teachers and the continuous professional development of teachers in schools require the skills of collaborative learning and work (Richter et al. 2011; Voogt et al. 2015). Therefore, it is important that GLAs in teacher education are designed properly and that student teachers consider participating in GLAs to be worthwhile.

However, GLAs are not always successful, and working in groups does not always lead to attainment of the learning goals (Kezar 2005; Brown and McIlroy 2011). A possible cause for not attaining the learning goals may lie in the students' resistance to participating in GLAs. To overcome students' resistance to group work, they need to be supported in their group work and they need appropriate scheduling, such as sufficient time to work on group assignments without the stress of other simultaneous courses (Payne et al. 2006). In addition, designing and managing GLAs is a challenging task in higher education (Hämäläinen 2012). Teachers consider the design of GLAs a complicated task that

CONTACT Miranda De Hei m.s.a.dehei@hhs.nl Department of Teacher Education, The Hague University of Applied Sciences, PO Box 13336, The Hague 2501 EH, Netherlands

often does not lead to the desired learning outcomes, and encounter problems such as freeriding of students, and issues with assessment and grading (Gillies and Boyle 2010). In a study of De Hei et al. (2016a) teacher educators were interviewed about their design of GLAs. They found that teacher educators experience problems specifically with the design of how students should collaborate during a GLA, in other words the way the collaboration is structured. Examples of structuring are the use of roles, distributing resources amongst students in order to make them interdependent, and using peer feedback as part of the grading. GLAs in which the structuring of the collaboration is not paid attention to may lead to freeriding of students.

Indeed, the design of a GLA is complex because of the pedagogical, interpersonal, environmental, and technological contexts simultaneously, in which various decisions need to be made regarding several GLA design components as well as their alignment (Dennen and Hoadley 2013). On the basis of a literature review of 14 meta-studies on the design of GLAs, De Hei et al. (2016b) developed a comprehensive framework: the Group Learning Activities Instructional Design (GLAID) framework. The GLAID framework distinguishes eight components for the design of GLAs: (1) interaction, (2) learning objectives and outcomes, (3) assessment, (4) task characteristics, (5) structuring, (6) guidance, (7) group constellation, and (8) facilities. In addition, the alignment between the various components is stressed as crucial for the design of a GLA. The implementation of instructional designs, such as designs for GLAs, strongly influences students' perceptions of their learning outcomes (Sahinkarakas, Inozu, and Yumru 2010). Hence, the current study examines students' evaluation of GLA design components and their relationships with students' perceived learning outcomes.

1.1. Student evaluations and learning outcomes

Student perceptions of the learning environment are related to their perceived learning outcomes, and may be related to the attained learning outcomes. Lizzio, Wilson, and Simons (2002) found that student perceptions of the learning environment are related not only to student satisfaction, but also to academic achievement and the development of key (or transferable) skills. They explain that students' perceptions of the learning benefits of courses are related to how they value different components of the design, such as task type or assessment. Salomon (1984) already found that students' perceptions of the learning materials affected their actual learning. Furthermore, Sahinkarakas, Inozu, and Yumru (2010) found among 142 higher education students (English Language Teaching Department) that their perceptions of the learning outcomes were strongly related to their evaluations of aspects of the curriculum: the lecturer, the classroom, the interaction, and the task-related activities.

In order to improve GLA designs so they can contribute to positive student evaluations and better learning outcomes, it is important to understand the relationship between the design components of a GLA and the learning outcomes from the students' perspective. Lizzio, Wilson, and Simons (2002) distinguished two kinds of perceived learning outcomes in university students' perceptions of their academic environment: (1) academic achievement and (2) key or transferable skills. In the context of GLAs in teacher education, academic achievement may be described as the attainment of declarative and procedural knowledge about a specific domain or subject. Key or transferable skills could be regarded as learning outcomes related to the future profession that concern the development of social skills (Gillies, Ashman, and Terwel 2008; Johnson and Johnson 2009a), the development of skills for implementing GLAs in their future classrooms (Ruys, Van Keer, and Aelterman 2010), and the development of collaborative skills for professional development purposes (Zwart et al. 2009).

1.2. Mediators between design and outcomes

The strength of the relationship between an educational design and its (perceived) learning outcomes appears to be related to the extent to which students feel engaged (Martin 2007). Furthermore, in assignments requiring student collaboration, the quality of the verbal interaction may

also influence the strength of the relationship between the design of the assignment and the learning outcomes (Janssen 2014). This means that both verbal interaction and engagement may mediate the relationship between students' evaluations of the design components of a GLA and their perceived learning outcomes. In the following two sections, each of these possible mediators will be discussed in more detail.

1.2.1. Verbal interaction

Verbal interaction appears to be an important aspect of the collaborative process needed to attain the learning goals (Strijbos, Martens, and Jochems 2004). Strijbos, Martens, and Jochems (2004) describe interaction as 'the heart of the matter': it is the process that influences how students collaborate and can, therefore, affect the learning outcomes of a group learning activity. Janssen (2014) also emphasises that (a) interaction is the key component in instructional methods aimed at fostering student collaboration and (b) interaction induces learning outcomes. Gomez, Wu, and Passerini (2010) found that students who have positive perceptions of team interaction report greater enjoyment in learning and perceive higher learning outcomes than students with a less positive perception of team interaction.

1.2.2. Engagement

Engagement refers to the behaviour of students when they are motivated to learn, work effectively, and employ their potential (Martin 2007) and is a second possible mediator between GLA design and learning outcomes. Reyes et al. (2012) found that student engagement was a mediator in the positive relationship between the emotional climate in classrooms and learning outcomes. Ferreira, Cardoso, and Abrantes (2011) found that intrinsic motivation served as a mediator between students' sense of belonging at school and perceived learning after completing a course: when students evaluated their sense of belonging at the school negatively this had a negative impact on intrinsic motivation and, consequently, on perceived learning. Finally, Figueira and Duartes (2011) implemented an intervention to increase student motivation during a course. This intervention resulted not only in higher motivational outcomes, but also, via student motivation, in increased quality of the learning outcomes that were required in the course. Based on these findings using students' course evaluations, it was expected that student engagement and motivation could also mediate the relationship between the design of a GLA and the perceived learning outcomes of GLAs.

1.3. Hypotheses and research question

In the current study, we investigated which components of implemented GLA designs students considered important for their perceived learning outcomes and to what extent student engagement and verbal interaction influenced this relationship. The focus was on two kinds of perceived learning outcomes: (1) outcomes regarding domain-specific knowledge and (2) outcomes regarding the future profession.

Our first two research questions were focused on the direct relationship between students' evaluations of GLA design and perceived learning outcomes:

(1) What is the relationship between students' evaluations of the design of GLAs and their perceived knowledge increase?
(2) What is the relationship between students' evaluations of the design of GLAs and their perceived learning outcomes for the future profession?

We also hypothesised that verbal interaction and engagement would mediate students' evaluations of the design aspects of GLAs and the two types of perceived learning outcomes. The third and fourth research questions were formulated as follows:

(3) To what extent do engagement and verbal interaction mediate the relationship between students' evaluations of the design of GLAs and their perceived knowledge increase?

(4) To what extent do engagement and verbal interaction mediate the relationship between students' evaluations of the design of GLAs and their perceived learning outcomes for the future profession?

2. Method

We examined the implementation of GLAs in six teacher education programmes. These GLAs differed in their learning objectives, tasks, and assessments. We applied retrospective analysis (Cobb et al. 2003) to relate perceived learning outcomes to how students value design components and the implementation of those design components.

2.1. Participants and research context

The participants in the current study were 290 students from the teacher education programmes (primary education) of six universities of applied sciences in the Netherlands. Teacher education programmes in the Netherlands are four-year bachelor programmes consisting of theoretical education at the university combined with internships at primary schools during parts of each academic year of the programme. The ages of the student teachers ranged from 16 to 26 years ($M = 20.3$, $SD = 2.0$); 76% were female. Seven GLAs were included in the study. In one teacher education programme, two different GLAs were used in two different academic years of the bachelor's programme. The teacher educators provided course documents related to the GLA and were interviewed about their implementation of the design. This information was used to investigate the implementation of each GLA (see Tables 1 and 2). Table 1 shows for each GLA the numbers of students and teacher educators, study level, duration of the GLA, and the size of subgroups for each GLA. Table 2 provides a brief description of the eight design components for each GLA (De Hei et al. 2016b).

2.2. Measures

Student perceptions of the design components and meditating variables were measured using a self-reporting survey. Several researchers argue that student self-report data should be interpreted cautiously and that the validity can be debated (e.g. Schwarz 1999; Porter 2011). However, Bowman (2010) argues that they do provide useful information because perceived learning gains are positively associated with student satisfaction. In an online survey study of 110 students participating in an undergraduate online course, Lee et al. (2011) found that students' perceptions of support operationalised as instructional support, peer support, and technical support were significantly related to course satisfaction. Moreover, Lizzio, Wilson, and Simons (2002) found that students' perceptions of the learning environment were related not only to their satisfaction, but also to their academic achievements and the development of key (i.e. transferable) skills.

Table 1. GLA assignments.

	Students (*N*)	Teacher educators (*N*)	Year of bachelor programme	Period in weeks the GLA could be worked on	Number of students per subgroup
Assignment 1	23	3	3	6	3–4
Assignment 2	69	7	1	8	12–13
Assignment 3	60	5	4	12	12–14
Assignment 4[a]	55	1	1	3	3
Assignment 5	16	2	1	10	3–4
Assignment 6[a/b]	41	3	3	1	3–6
Assignment 7	26	2	1	8	3–4

[a]Assignments in the same teacher education programme.
[b]Students were allowed to work full-time for an entire week on this assignment.

Table 2. GLA assignments as described in the course documents and elaborated by the teacher educators in the interviews.

Assignment no.	Learning objectives/ outcomes	Interaction	Assessment	Task characteristics	Structuring	Guidance	Group constellation	Facilities
1	More than 30 learning objectives in the course description focused on three domains (geography, history and biology) and seven competencies	Exchange of ideas and giving peer feedback	Written product containing the lessons and evaluations, group grade	Designing lesson cycle on the theme 'evolution' integrating geography, history and biology	Jointly performing the designed lessons	One time obligatory halfway the GLA and on request, focus on the final product	Self-chosen groups of 3 or 4 students	Format for the design of lessons
2	To be able to design lessons for a primary school group	Exchange of ideas and task division	Perform the lessons in groups: group grade, individual grade for individual report	Design an afternoon with lessons for a third and fourth grade class of a primary school focused on the theme of a picture book	Students individually reflect on their role in the collaboration after the GLA is finished	Weekly focus varying per teacher educator (on the process of collaboration and/or the final product)	Students randomly assigned to groups of 12 to 13 students	Electronic learning environment only used to host the course documents: course description, assessment form with criteria
3	Gain knowledge on school innovations, develop collaboration skills and present a project	Exchange of ideas and task division	Report about the design of the innovation and possibilities for implementation, presentation of the report, group grades	Design an innovation for a primary school	Group evaluation during the GLA of the collaboration process	Weekly focus on the process of collaboration	Students chose an innovation focus and were assigned to students with the same focus, 12 to 14 students per group	Format for the steps to take in a school innovation
4	Develop domain-specific skills and collaboration skills	Exchanging ideas and explaining to others	Product: stop-motion movie, presentation of the collaboration process. Peer assessment of the presentation, teacher assessing the group product	Make a stop-motion movie with the theme 'travelling from one point to the other'	None	Weekly, focus on the final product	Self-chosen groups of 3 students	Electronic learning environment only used to host the course documents. Software to produce a 'stop-motion' movie
5	Develop communication and	Exchange of ideas, task	Perform the lessons in groups, group grade	Design a morning for a primary	Students individually	Weekly, on request or when		Electronic learning environment only

	social skills, develop lesson plans	division and giving peer feedback		school class with lessons focused on one theme	reflect on their role in the collaboration after the GLA is finished	the teacher educator found it was necessary	Self-chosen groups of 3 or 4 students	used to host the course documents
6	Abstracting a theme from information of three domains, formulate learning questions, develop research skills	Brainstorming and task division	Presence during the meeting, presentation of the product, formative peer feedback	Perform practitioner research on a theme and develop lessons that relates to the researched theme	None	One time at the start, after that on request	Self-chosen groups of 3 to 6 students	Electronic learning environment only used to host the course documents, supporting lectures regarding domain knowledge
7	Develop social skills and practitioner research skills	Exchange of ideas, task division, discussing and reaching consensus	Practitioner research report and presentation of the report, group grades	Perform practitioner research within the theme: 'the teacher as jack of all trades'	Specific group and individual feedback on the collaboration	Weekly	Students were randomly assigned to groups of 3 or 4 students	Electronic learning environment only used to host the course documents

During the final meeting of the GLA, or in the week immediately after the GLA was completed, the students completed a survey with pre-structured answer options (5-point Likert-type scale with 1 = strongly disagree and 5 = strongly agree). This survey was used to examine their evaluations of the GLAs. This survey was constructed using eight design components of the GLAID framework (De Hei et al. 2016b). The component learning objectives and outcomes refers to two perceived learning outcomes: (1) perceived knowledge increase (declarative and procedural knowledge) and (2) learning outcomes for the future profession (social skills and preparation for professional development). The component interaction was understood as the verbal representations of students in the collaboration process (such as listening, explaining, and discussing). This component was hypothesised to act as a student variable that mediates the evaluation of GLAs. Engagement with GLAs was hypothesised as a further mediating variable (Martin 2007).

Together with the two learning outcomes and the two mediators, the remaining six components to design GLAs formed the basis of the survey. The survey consisted of 58 items. A Principal Component Analysis with Oblimin rotation (KMO = 0.858, $R^2 = 57.93$) was performed on the data from the 290 participants to examine the construct validity of the survey, using as inclusion criterion a factor loading of $\geq$0.4 on one factor only. This led to the addition of a scale (contribution: the extent to which each individual student of a group contributes to and is responsible for group performance and the group learning product). The facilities scale (students' evaluations of available time, available rooms, and digital support) was left out of the analyses because of low reliability. For each scale, Table 3 provides the number of items, an example item, reliability in terms of Cronbach's α, descriptive statistics, and the number of students for which a scale mean was computed.

2.3. Analysis

As the student data are nested within seven different GLAs, multilevel analyses were used to test whether the variance at the level of the seven GLAs in both dependent variables differed significantly from zero. This was not the case and consequently the analyses were performed at the student level only.

Two multiple mediation regression analyses, one for each of the dependent variables, were performed using an SPSS macro developed by Hayes and Preacher (2014). The macro uses 5000 bootstrap resamples to generate 95% confidence intervals for the indirect effect of the mediators on the

Table 3. Variables of the study.

	N items	Example item	α	*M*	SD	*N* students
Perceived knowledge increase	6	I gained new insights about knowledge I already had by listening to other students during this GLA	0.79	3.59	0.64	288
Learning outcomes for future profession	6	I consider this GLA an adequate activity to prepare for my future profession	0.81	3.56	0.64	290
Verbal interaction	3	Working on this GLA I improved my skills in articulating my ideas towards my fellow students	0.75	3.21	0.80	288
Engagement[a]	5	During the GLA I am driven to complete the assignment in a good way	0.62	3.91	0.57	288
Contribution	3	In the group I participated in, every group member contributed equally to the final product	0.78	3.40	1.01	289
Assessment Quality	4	It was clear beforehand how the GLA would be assessed	0.72	3.41	0.74	281
Task characteristics	4	The task was suitable to work on in collaboration	0.69	3.72	0.68	289
Structuring[a]	4	It was clear how we were supposed to collaborate as a group in this GLA	0.61	3.47	0.74	288
Guidance	5	Our teacher was available for us in case we needed him/her	0.85	3.77	0.81	280
Group constellation	5	Knowledge and prior experience of the group members were complementary	0.75	3.83	0.70	288

[a]Reliability after using the Spearman–Brown formula to lengthen the scale to 6 items (Engagement, α = 0.66 and Structuring, α = 0.70).

dependent variables. The two regression analyses are visualized in Figure 1: the c-path represents the relation between the independent variables and the dependent variable in the absence of the mediators (total effect, unmediated model), the c^1 path represents the same relation taking into account the effect of the mediators in this relation (direct effect, mediated model). In both analyses, verbal interaction and engagement were included as mediators and either perceived knowledge increase or learning outcomes for the future profession as dependent variable. Separate regression analyses were performed for each dependent variable, because this study specifically focused on the relationship between the design components and each of the dependent variables. The following independent variables were included: contribution, assessment quality, task characteristics, structuring, guidance, and group constellation. Students' prior educational level, year of bachelor's programme, and gender were included as covariates (not visualized in Figure 1). In Figure 1, 'a' represents the relationship between the perceived design components and the mediators and 'b' the relationship between the mediators and the perceived learning outcomes.

In mediation analyses, complementary mediation indicates the likely presence of another mediator that was not included in the analyses. Full mediation indicates that the independent variable is only related with the dependent variable through the mediator. The independent variable has no direct effect.

3. Results

Before discussing the results of the multiple regression analyses, we report the correlations between the independent variables, the mediators, and the dependent variables in Table 4.

3.1. Perceived knowledge increase

3.1.1. Direct relationship with students' evaluation of the design

The design components that significantly relate to perceived knowledge increase are task characteristics ($B = 0.313$; SE = 0.055) and group constellation ($B = 0.367$; SE = 0.055), as shown in Table A1 of the appendix (total effects unmediated model: $R^2 = 0.457$). Our findings confirm that there is a positive relationship between students' evaluations of some of the design components and perceived increase in knowledge.

3.1.2. Mediation by verbal interaction and engagement

The results of the mediator regression analyses are summarized in Tables A2 and A3 of the appendix. Of the two mediators, only verbal interaction was significantly related to perceived knowledge

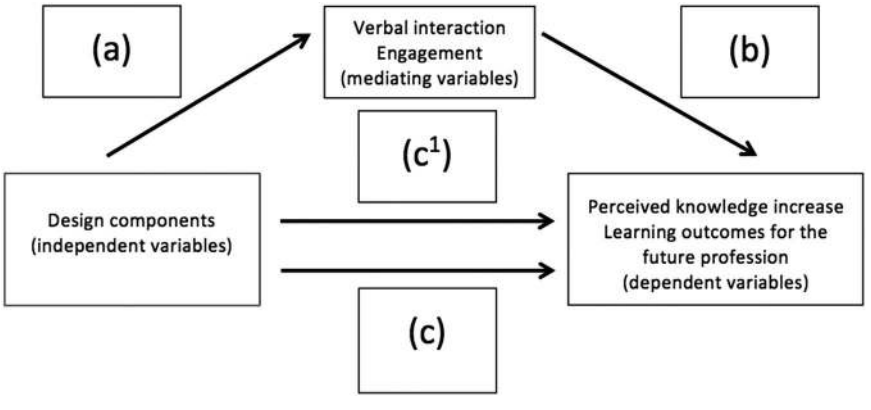

Figure 1. Testing mediation of verbal interaction and engagement.

Table 4. Correlations of the independent, dependent and mediator variables.

	1	2	3	4	5	6	7	8	9	10
Perceived knowledge increase (1)	–	0.65**	0.33**	0.44**	0.22**	0.31**	0.57**	0.34**	0.35**	0.56**
Learning outcomes for the future profession (2)		–	0.45**	0.54**	0.10	0.37**	0.65**	0.37**	0.44**	0.34**
Verbal interaction (3)			–	0.30**	0.03	0.19**	0.37**	0.28**	0.21**	0.19**
Engagement (4)				–	0.14*	0.40**	0.62**	0.54**	0.43**	0.48**
Contribution (5)					–	0.09	0.16**	0.26**	0.05	0.49**
Assessment quality (6)						–	0.42**	0.40**	0.42**	0.26**
Task characteristics (7)							–	0.46**	0.43**	0.45**
Structuring (8)								–	0.39**	0.36**
Guidance (9)									–	0.21**
Group constellation (10)										–

*$p < .05$.
**$p < .01$.

increase ($B = 0.111$; SE = 0.040). Furthermore, we found that verbal interaction mediated the relationship between students' evaluations of task characteristics and perceived knowledge increase (CI [0.006, 0.089]), leading to a smaller but still significant direct relationship between task characteristics and perceived knowledge increase ($B = 0.271$; SE = 0.060). This means that we found a complementary mediation (Zhao, Lynch, and Chen 2010) of verbal interaction in the relationship between students' evaluations of the task characteristics of GLAs and their perceived knowledge increase. Furthermore, verbal interaction mediated the relationship between students' evaluations of the contributions of the group members and perceived knowledge increase in the absence of a significant direct relation between evaluation of the design and perceived knowledge increase. This indicates a full mediation (Zhao, Lynch, and Chen 2010) of verbal interaction in this relationship. The relationship between contribution and verbal interaction was negative, which means that the higher the evaluation of contributions, the lower the evaluation of verbal interaction. Figure 2 visualises our findings on the mediation of verbal interaction.

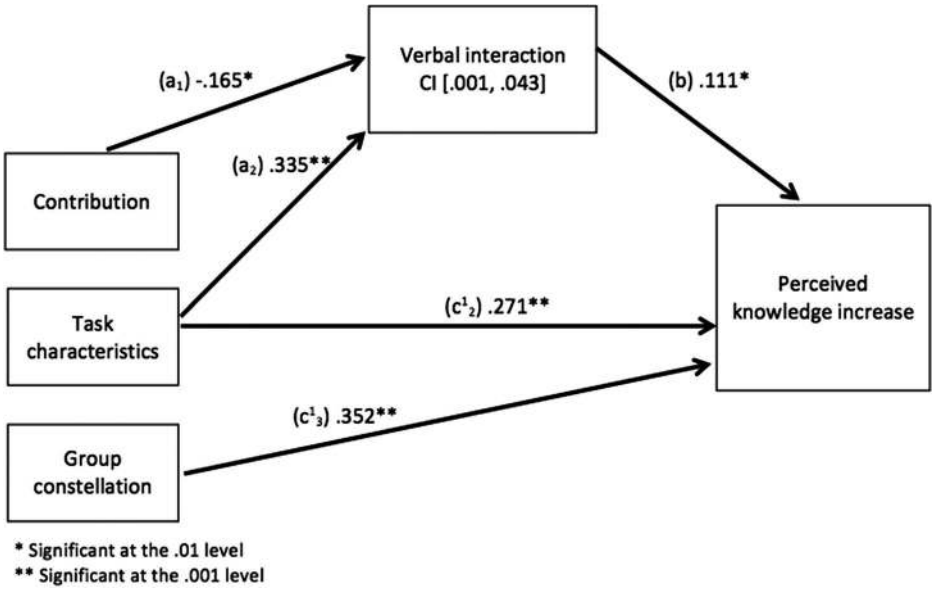

Figure 2. Verbal interaction partially mediating between students' evaluations of design components and perceived knowledge increase.

3.2. Perceived learning outcomes for the future profession

3.2.1. Direct relationships with students' evaluations of the design components

The design components that relate to perceived learning outcomes for the future profession are task characteristics ($B = 0.455$; SE = 0.054) and guidance ($B = 0.119$; SE = 0.044), as can be seen in Table A4 of the appendix (total effects unmediated model: $R^2 = 0.463$). Our findings confirm that there is a positive relationship between students' evaluations of the design components and perceived learning outcomes for the future profession.

3.2.2. Mediation by verbal interaction and engagement

The results of the mediator regression analyses are summarised in Tables A5 and A6 of the appendix. Both verbal interaction ($B = 0.178$; SE = 0.038) and engagement ($B = 0.225$; SE = 0.073) were significantly related to perceived learning outcomes for the future profession. Students' evaluations of task characteristics had complementary mediation via verbal interaction (CI [0.021, 0.120]) and engagement (CI [0.025, 0.116]), leading to smaller though significant direct relationships (Verbal interaction, $B = 0.335$; SE = 0.084, and Engagement, $B = 0.286$; SE = 0.043). Moreover, the results indicate that engagement fully mediated the relationship between the learning outcomes for the future profession and the evaluation of four design variables: contribution (CI [−0.045, −0.052]), structuring (CI [0.015, 0.080]), guidance (CI [0.006, 0.057]), and group constellation (CI [0.016, 0.106]). This means that the evaluation of these design components was only related to the learning outcomes for the future profession through student engagement: the more positive the evaluation, the higher students' engagement and the higher the perceived learning outcomes. Figure 3 visualizes our findings for the mediation of verbal interaction and engagement in relation to the learning outcomes for the future profession.

4. Discussion

In this study, the relationships between students' evaluations of the design of GLAs and their perceived learning outcomes were examined. We found that students' evaluations of task characteristics and group constellation were positively related to a perceived knowledge increase. We also found that students' evaluations of task characteristics and guidance were positively related to their perceptions of their learning outcomes for their future profession. In addition to these direct relationships, we found several mediated relationships, indicating the importance of student engagement and interaction as mediators between the design of GLAs and perceived learning outcomes.

We found that verbal interaction partly mediates learning outcomes for the future profession, and it fully mediates the perceived knowledge increase. Furthermore, our analysis indicated that engagement fully mediates learning outcomes for the future profession. Therefore, our findings imply that choices educational designers make in the design of GLAs should be aimed at triggering engagement and interaction, because those mediators contribute significantly to the learning outcomes.

4.1. Importance of task characteristics

Students' evaluations of task characteristics were directly and indirectly related to both kinds of learning outcomes. Evaluation of the design component task characteristics explained the largest proportion of variance in both outcome variables. Therefore, the quality of the task seems to be a dominant variable for explaining the perceived learning outcomes of GLAs. This conclusion is related to the findings of Wieland (2011), who found that students learn more when task characteristics are described in detail. Her findings revealed that students who worked collaboratively on an assignment with precise instructions outperformed students who worked on an assignment with general instructions.

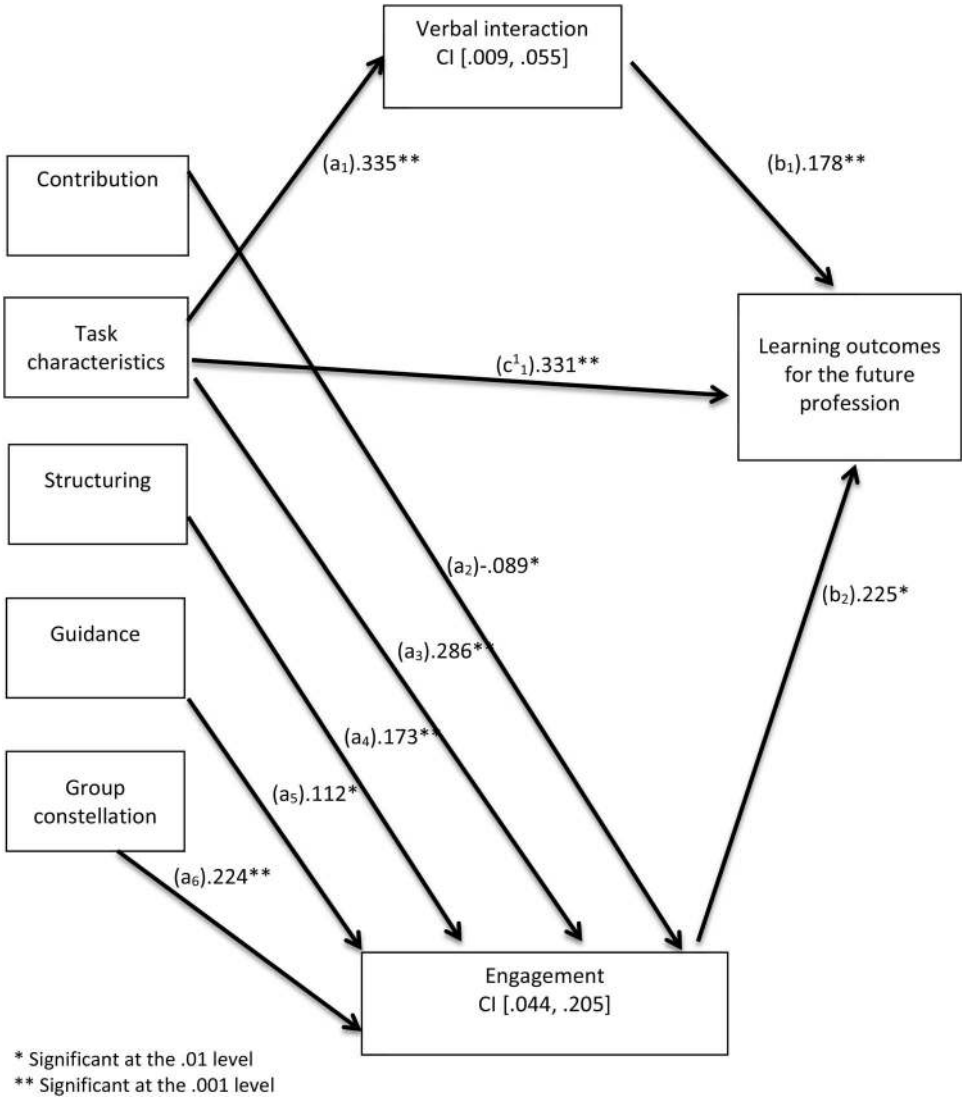

Figure 3. Verbal interaction and engagement partially mediating between students' evaluations of design components and learning outcomes for the future profession.

Sockalingam, Rotgans, and Schmidt (2012) describe a validated and reliable quality-rating scale to rate the quality of problems in problem-based learning, which might be useful for the evaluation of task design in GLAs. They found five aspects that indicate the task quality: the extent to which a task (1) leads to learning objectives, (2) is familiar, (3) triggers students' interest, (4) stimulates students' critical reasoning, and (5) promotes collaborative learning.

4.2. Implications for GLAs in teacher education

4.2.1. Engagement related to task characteristics

The evaluation of task characteristics is a dominant variable in explaining differences between students in perceived learning outcomes. This implies that teacher educators need to explicitly select tasks that are aligned with the desired learning outcomes. For example, if the main learning goal

of the GLA is to acquire knowledge about a particular topic, the task characteristics should lead to activities that induce collaboration and prevent the students from dividing the work: if each student works on a different aspect of the task, they might not acquire sufficient knowledge about the topic as a whole.

Furthermore, to induce student engagement, authentic tasks are recommended for GLAs (Hämäläinen and Vähäsantanen 2011). Another important characteristic of the task that is assumed to lead to better achievement is its complexity. In their review of research comparing the effectiveness of individual learning environments and collaborative learning environments, Kirschner, Paas, and Kirscher (2009) argue that the more complex tasks are, the higher the learning outcomes of group learning. Yet, Boekaerts and Minnaert (2006) found that learning tasks that matched the competence level of the students generated topic interest. They argue that a task needs to elicit students' perceived autonomy and feelings of competence to complete the task. We conclude that a positive evaluation of task characteristics might be influenced by the alignment of task difficulty and student competence.

Another implication for teacher education is the use of resources that induce intellectual conflict: resources that provide students with information that seems inconsistent with what they already know. Johnson and Johnson (2009b) describe this procedure as constructive controversy. They state that constructive controversy stimulates students' effort to seek further information and to study more and longer. In other words, it fuels their engagement.

4.2.2. Engagement related to other design components

Our findings stress the important mediating role of student engagement in the design of GLAs. Therefore, the design of GLAs should first be focused on the extent to which structuring, guidance, and group constellation induce the engagement of students with GLAs.

The component of structuring concerns instructing students in how to collaborate during the task: for example, by appointing roles or distributing the resources among students in order to make them interdependent to complete the task. Roles contribute to student awareness of what they need to do in the collaboration (Strijbos, Martens, and Jochems 2004). Structuring may also lead to more self-efficacy, which in turn may lead to engaged and motivated students (Pintrich 2003).

How guidance was perceived was also related to the engagement of students: the higher they evaluated the teacher guidance of the GLAs, the more they felt engaged. This is in line with findings of Van Ginkel et al. (2015) who found that students highly value teacher feedback on their performance.

In the design of a GLA, the guidance could, for example, describe how teachers guide the focus of the attention of their students (McGregor 2008) and as part of the design the guiding teacher should model the behaviour he/she want their students to learn (Webb 2010). The latter includes posing questions to elaborate on argumentations or summarising the contributions of others to check whether the content of the interaction has been understood correctly.

Engagement was also induced by how students valued the group constellation. We found that the more satisfied students were with the group size and composition, the more engaged they felt. Consequently, we advise teacher educators to deliberately decide on group composition, while keeping in mind what this means for the engagement of the students. For example, teacher educators should decide whether the groups will be homogeneous or heterogeneous, and which criteria can be used for group composition, such as age, gender, achievement level, motivation, or personal interests. One important consideration in group constellation is how the team characteristics (group size and composition) match the task demands. For example, in some tasks it is important to reflect on a particular problem from different perspectives in order to stimulate students' broader awareness and understanding of the problem. The teacher educator might compose collaborative groups of students from different educational programmes or with different motivations to work on these particular problems. The different perspectives of these students will stimulate group discussion and reflection, which may contribute to student engagement with the task.

4.3. Limitations and future research

The data were collected in teacher education programmes from six different universities of applied sciences geographically spread over the Netherlands. The teacher education programmes involved volunteered to take part in the research and therefore they were not randomly selected. The context of teacher education programmes may differ from other higher education teachers and students in how they evaluate their GLAs. Learning and education, including collaborative learning and GLAs, is the domain of their (future) work practices. This is less the case for other higher education programmes and therefore collaborative learning in these programmes might function in a different way. Findings from our study might be partly biased and therefore should be interpreted with caution in other higher educational settings. In future research a mixture of higher education programmes could be involved to extend the generalizability of the findings of the current study.

The use of self-reports for this study was considered to be adequate for answering the research questions; however, it does not yield information about the actual acquired learning outcomes. Therefore, the use of self-reports may be seen as a limitation. In further studies the use of other types of data, such as observations, teacher interviews, and pre–post-tests about content learning, may be used to provide alternative information on the learning activities and outcomes.

The third limitation of this study regards the practical implications for the design of GLAs. We found that high perceptions of task characteristics, guidance, and group constellation are related to higher perceived learning outcomes, but this study does not give indications of which types of tasks, guidance, and group constellation are the most beneficial for higher engagement and higher interaction quality. To yield more insights into the effectiveness of particular design components, future researchers might examine the relationships of those design components with learning outcome measures using a quasi-experimental design. In such studies, design components could be manipulated and objective learning outcomes could be used as outcome measures (such as test scores and observations).

The mediation analyses showed complementary mediation of verbal interaction and engagement, indicating the existence of another mediator not included. To gain a comprehensive insight into the relationship between the evaluated design components and the perceived learning outcomes, future researchers might explore other mediators. An example of a possible mediator is described by Fransen, Kirschner, and Erkens (2011): interpersonal trust contributes to the building of shared mental models, which in their turn contribute to effective group work.

4.4. Concluding remark

We explored the relationship between students' evaluations of the implemented design components and the perceived learning outcomes. Our findings show that the extent to which GLAs contribute to positive student perceptions of the learning outcomes largely depends on how students evaluate the implemented design components and how these evaluations are related to student engagement and student interaction. These insights contribute to advanced understanding of the process of GLAs and therefore they can be used to further improve the learning outcomes of GLAs in higher education.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Wilfried Admiraal http://orcid.org/0000-0002-1627-3420

References

Boekaerts, M., and A. Minnaert. 2006. "Affective and Motivational Outcomes of Working in Collaborative Groups." *Educational Psychology* 26 (2): 187–208. doi:10.1080/01443410500344217.

Bowman, N. A. 2010. "Can 1st Year College Students Accurately Report Their Learning and Development?" *American Educational Research Journal* 47 (2): 466–96.

Brown, C. A., and K. McIlroy. 2011. "Group Work in Healthcare Students' Education: What Do We Think We Are Doing?" *Assessment & Evaluation in Higher Education* 36 (6): 687–99. doi:10.1080/02602938.2010.483275.

Cobb, P., A. diSessa, R. Lehrer, and L. Schauble. 2003. "Design Experiments in Educational Research." *Educational Researcher* 32 (1): 9–13. doi:10.3102/0013189X032001009.

De Hei, M. S. A., E. Sjoer, J. W. Strijbos, and W. F. Admiraal. 2016a. "Teacher Educators' Design and Implementation of Group Learning Activities." *Educational Studies* 42 (4): 394–409. doi:10.1080/03055698.2016.1206461.

De Hei, M. S. A., J. W. Strijbos, E. Sjoer, and W. F. Admiraal. 2016b. "Thematic Review of Approaches to Design Group Learning Activities in Higher Education: The Development of a Comprehensive Framework." *Educational Reserach Review* 18: 33–45. doi:10.1016/j.eudurev.2016.01.001.

Dennen, V. P., and C. Hoadley. 2013. "Designing Collaborative Learning Through Computer Support." In *The International Handbook of Collaborative Learning*, edited by C. E Hmelo-Silver, C. A. Chinn, C. K. K. Chan, and A. O'Donnell, 389–402. New York: Routledge. doi:10.3102/0002831209353595.

Ferreira, M., A. P. Cardoso, and L. Abrantes. 2011. "Motivation and Relationship of the Student with the School as Factors Involved in the Perceived Learning." *Procedia – Social and Behavioral Sciences* 29: 1707–14. doi:10.1016/j.sbspro.2011.11.416.

Figueira, A. I., and A. M. Duartes. 2011. "Increasing the Quality of Learning Through Changes in Motivation." *Procedia – Social and Behavioral Sciences* 29: 1373–79. doi:10.1016/j.sbspro.2011.11.376.

Fransen, J., P. Kirschner, and G. Erkens. 2011. "Mediating Team Effectiveness in the Context of Collaborative Learning: The Importance of Team and Task Awareness." *Computers in Human Behaviour* 27 (3): 1103–13. doi:10.1016/j.chb.2010.05.017.

Gillies, R. M., A. F. Ashman, and J. Terwel. 2008. *The Teacher's Role in Implementing Cooperative Learning in the Classroom*. New York: Springer.

Gillies, R. M., and M. Boyle. 2010. "Teachers' Reflections on Cooperative Learning: Issues of Implementation." *Teaching and Teacher Education* 26: 933–40. doi:10.1016/j.tate.2009.10.034.

Gomez, E. A., D. Wu, and K. Passerini. 2010. "Computer-Supported Team-Based Learning: The Impact of Motivation, Enjoyment and Team Contributions on Learning Outcomes." *Computers & Education* 55 (1): 378–90. doi:10.1016/j.compedu.2010.02.003.

Hämäläinen, R. 2012. "Methodological Reflections: Designing and Understanding Computer-Supported Collaborative Learning." *Teaching in Higher Education* 17 (5): 603–14. doi:10.1080/13562517.2012.658556.

Hämäläinen, R., and K. Vähäsantanen. 2011. "Theoretical and Pedagogical Perspectives on Orchestrating Creativity and Collaborative Learning." *Educational Research Review* 6 (3): 169–84. doi:10.1016/j.edurev.2011.08.001.

Hayes, A. F., and K. J. Preacher. 2014. "Statistical Mediation Analysis with a Multicategorical Independent Variable." *British Journal of Mathematical and Statistical Psychology* 67 (3): 451–70. doi:10.1111/bmsp.12028.

Janssen, J. 2014. *Opening the Black box of Collaborative Learning: A Meta-analysis Investigating the Antecedents and Consequences of Collaborative Interaction*. Report (No. 411-11-632) Commissioned by NWO-PROO and NRO. Utrecht: University of Utrecht.

Johnson, D. W., and R. T. Johnson. 2009a. "An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning." *Educational Researcher* 38 (5): 365–79. doi:10.3102/0013189X09339057.

Johnson, D. W., and R. T. Johnson. 2009b. "Energizing Learning: The Instructional Power of Conflict." *Educational Researcher* 38 (1): 37–51. doi:10.3102/0013189X08330540.

Kezar, A. 2005. "Redesigning for Collaboration within Higher Education Institutions: An Exploration into the Developmental Process." *Research in Higher Education* 46 (7): 831–60. doi:10.1007/s11162-004-6227-5.

Kirschner, F., F. Paas, and P. A. Kirscher. 2009. "A Cognitive Load Approach to Collaborative Learning: United Brains for Complex Tasks." *Educational Psychology Review* 21 (1): 31–42. doi:10.1007/s10648-008-9095-2.

Lee, S. J., S. Srinivasan, T. Trail, D. Lewis, and S. Lopez. 2011. "Examining the Relationship among Student Perception of Support, Course Satisfaction, and Learning Outcomes in Online Learning." *The Internet and Higher Education* 14 (3): 158–63. doi:10.1016/j.iheduc.2011.04.001.

Lizzio, A., K. Wilson, and R. Simons. 2002. "University Students' Perceptions of the Learning Environment and Academic Outcomes: Implications for Theory and Practice." *Studies in Higher Education* 27 (1): 27–52. doi:10.1080/03075070120099359.

Martin, A. J. 2007. "Examining a Multidimensional Model of Student Motivation and Engagement Using a Construct Validation Approach." *British Journal of Educational Psychology* 77 (2): 413–40. doi:10.1348/000709906X118036.

McGregor, D. 2008. "The Influence of Task Structure on Students' Learning Processes: Observations from Case Studies in Secondary School Science." *Journal of Curriculum Studies* 40 (4): 509–40. doi:10.1080/00220270701813282.

Payne, B. K., E. Monk-Turner, D. Smith, and M. Sumter. 2006. "Improving Group Work: Voices of Students." *Education* 126 (3): 441–48.
Pintrich, P. R. 2003. "A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts." *Journal of Educational Psychology* 95 (4): 667–86. doi:10.1037/0022-0663.95.4.667.
Porter, S. R. 2011. "Do College Student Surveys Have Any Validity?" *The Review of Higher Education* 35 (1): 45–76. Accessed 6 November 2015. https://muse.jhu.edu.
Reyes, M. R., M. A. Bracket, S. E. Rivers, M. White, and P. Salovey. 2012. "Classroom Emotional Climate, Student Engagement, and Academic Achievement." *Journal of Educational Psychology* 104 (3): 700–12. doi:10.1037/a0027268.
Richter, D., M. Kunter, U. Klusmann, O. Lüdtke, and B. Baumert. 2011. "Professional Development Across the Teaching Career: Teachers' Uptake of Formal and Informal Learning Opportunities." *Teaching and Teacher Education* 27 (1): 116–26. doi:10.1016/j.tate.2010.07.008.
Ruys, I., H. Van Keer, and A. Aelterman. 2010. "Collaborative Learning in Pre-service Teacher Education: An Exploratory Study on Related Conceptions, Self-efficacy and Implementation." *Educational Studies* 36 (5): 537–53. doi:10.1080/03055691003729021.
Sahinkarakas, S., J. Inozu, and H. Yumru. 2010. "The Influence of Higher Education Experiences on ELT Students' Learning Outcomes." *Procedia – Social and Behavioral Sciences* 2: 4183–88. doi:10.1016/j.sbspro.2010.03.661.
Salomon, G. 1984. "Television Is 'Easy' and Print Is 'Tough': The Differential Investment of Mental Effort in Learning as a Function of Perceptions and Attributions." *Journal of Educational Psychology* 76 (4): 647–58. doi:10.1037/0022-0663.76.4.647.
Schwarz, N. 1999. Self-reports: How the Questions Shape the Answers. *American Psychologist* 54 (2): 93–105. doi:10.1037/0003-066X.54.2.93.
Sockalingam, N., J. Rotgans, and H. Schmidt. 2012. "Assessing the Quality of Problems in Problem-Based Learning." *International Journal of Teaching and Learning in Higher Education* 24 (1): 43–51.
Strijbos, J. W., R. L. Martens, and W. M. G. Jochems. 2004. "Designing for Interaction: Six Steps to Designing Computer-Supported Group-Based Learning." *Computers & Education* 42 (4): 403–24. doi:10.1016/j.compedu.2003.10.004.
Van Ginkel, S., J. Gulikers, H. Biemans, and M. Mulder. 2015. "The Impact of the Feedback Source on Developing Oral Presentation Competence." *Studies in Higher Education*, 1–15. doi:10.1080/03075079.2015.1117064.
Voogt, J., T. Laferrière, A. Breuleux, R. C. Itow, D. T. Hickey, and S. McKenney. 2015. "Collaborative Design as a Form of Professional Development." *Instructional Science* 43 (2): 259–82. doi:10.1007/s11251-014-9340-7.
Webb, N. M. 2010. "Peer Learning in the Classroom." In *Social and Emotional Aspects of Learning*, edited by S. Järvelä, 636–42. Oxford: Elsevier Academic Press.
Wieland, K. 2011. *The Effects of Different Computer-Supported Collaboration Scripts on Students' Learning Processes and Outcome in a Simulation-Based Collaborative Learning Environment* (Order No. 3477281). Available from ProQuest Dissertations and Theses Global (897546559). http://search.proquest.com/docview/897546559?accountid=12045.
Zhao, X., J. G. Lynch, and Q. Chen. 2010. "Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis." *Journal of Consumer Research* 37 (2): 197–206. doi:10.1086/65127.
Zwart, R. C., T. Wubbels, T. Bergen, and S. Bolhuis. 2009. "Which Characteristics of a Reciprocal Peer Coaching Context Affect Teacher Learning as Perceived by Teachers and Their Students?" *Journal of Teacher Education* 60 (3): 243–57. doi:10.1177/0022487109336968.

Appendix

The paths we refer to in the tables are shown in Figure 1.

Table A1. Total effects of student evaluations of the design components on perceived knowledge increase mediation model.

Paths	R^2	Coefficient	SE	p (two-tailed)
Total effect (unmediated model) (student evaluation of design components → perceived knowledge gains = *c-path*)	0.457			<.001
Constant		0.566	0.226	<.05
Contribution		−0.016	0.035	.65
Assessment quality		0.014	0.046	.76
Task characteristics		0.313	0.055	<.001
Structuring		0.033	0.049	.51
Guidance		0.057	0.044	.20
Group constellation		0.367	0.055	<.001
Gender		0.004	0.066	.95
Prior education		0.011	0.050	.82
Year of bachelor programme		0.058	0.025	<.05

Table A2. Direct effects of student evaluation of the design components on perceived knowledge increase mediation model.

Paths	R^2	Coefficient	SE	*p* (two-tailed)
Direct effect (*mediated model*) (*c^1 path*)	0.203			<.001
Constant		0.353	0.255	.168
Contribution		0.004	0.036	.916
Assessment quality		0.015	0.046	.740
Task characteristics		0.271	0.060	<.001
Structuring		0.017	0.051	.734
Guidance		0.047	0.045	.294
Group constellation		0.352	0.057	<.001
Gender		0.003	0.065	.965
Prior education		0.014	0.049	.779
Year of bachelor programme		0.070	0.026	<.01
Direct effects on mediators (Student evaluation of design components → Verbal interaction = *a paths*)	0.198			<.001
Constant		1.715	0.346	<.001
Contribution		−0.165	0.054	<.01
Assessment quality		−0.012	0.070	.861
Task characteristics		0.335	0.084	<.001
Structuring		0.112	0.075	.137
Guidance		0.075	0.068	.269
Group constellation		0.115	0.084	.172
Gender		0.071	0.101	.479
Prior education		−0.030	0.076	.691
Year of bachelor programme		−0.102	0.039	<.01
(Student evaluation of design components → Engagement = *a paths*)	0.568			<.001
Constant		1.317	0.179	<.001
Contribution		−0.089	0.029	<.01
Assessment quality		0.023	0.036	.521
Task characteristics		0.286	0.043	<.001
Structuring		0.173	0.039	<.001
Guidance		0.112	0.035	<.01
Group constellation		0.224	0.043	<.001
Gender		−0.061	0.052	.240
Prior education		0.030	0.039	.451
Year of bachelor programme		−0.077	0.020	<.001
Direct effects of mediators on perceived knowledge increase (b paths)				
(Verbal interaction → perceived knowledge increase)		0.111	0.040	<.01
(Engagement → perceived knowledge increase)		0.017	0.077	.82

Table A3. Indirect effects of student evaluation of the design components on perceived knowledge increase through proposed mediators' interaction and engagement.

Mediator	Effect	SE	95% CI interval lowest level	95% CI interval highest level
Verbal interaction	0.018	0.011	0.001	0.043
Contribution	−0.018	0.012	−0.50	−0.003
Assessment quality	−0.001	0.011	−0.028	0.017
Task characteristics	0.037	0.021	0.006	0.089
Structuring	0.013	0.011	−0.002	0.044
Guidance	0.008	0.010	−0.005	0.038
Group constellation	0.013	0.013	−0.006	0.049
Engagement	0.009	0.047	−0.082	0.104

Table A4. Total effects of student evaluation of the design components on learning outcomes for the future profession mediation model.

Paths	R^2	Coefficient	SE	*p* (two-tailed)
Total effect (unmediated model) (Student evaluation of design components → Learning outcomes for the future profession = *c-path*)	0.463			<.001
Constant		0.868	0.224	<.001
Contribution		−0.042	0.035	.223
Assessment quality		0.050	0.045	.272
Task characteristics		0.455	0.054	<.001
Structuring		0.070	0.049	.148

(*Continued*)

Table A4. Continued.

Paths	R^2	Coefficient	SE	p (two-tailed)
Guidance		0.119	0.044	<.01
Group constellation		0.081	0.054	.132
Gender		0.079	0.061	.226
Prior education		−0.002	0.049	.972
Year of bachelor programme		0.000	0.007	.994

Table A5. Direct effects of student evaluation of the design components on learning outcomes for the future profession mediation model.

Paths	R^2	Coefficient	SE	p (two-tailed)
Direct effect (mediated model) (c^1 path)	0.101			<.001
Constant		0.267	0.242	.271
Contribution		0.007	0.034	.836
Assessment quality		0.047	0.043	.278
Task characteristics		0.331	0.057	<.001
Structuring		0.012	0.048	.810
Guidance		0.080	0.042	.058
Group constellation		0.011	0.054	.845
Gender		0.078	0.062	.210
Prior education		−0.003	0.047	.948
Year of bachelor programme		0.036	0.025	.150
Direct effects of student evaluation of design components on mediators, values identical as in table A2				
Direct effects of mediators on learning outcomes for the future profession (b paths)				
(Verbal interaction → learning outcomes for the future profession)		0.178	0.038	<.001
(Engagement → learning outcomes for the future profession)		0.225	0.073	<.01

Table A6. Indirect effects of student evaluation of the design components on perceived learning outcomes for the future profession through proposed mediators' interaction and engagement.

Mediator	Effect	SE	95% CI interval lowest level	95% CI interval highest level
Verbal interaction	0.029	0.013	0.009	0.055
Contribution	−0.029	0.014	−0.063	−0.008
Assessment quality	−0.002	0.016	−0.036	0.029
Task characteristics	0.060	0.025	0.021	0.120
Structuring	0.020	0.015	−0.006	0.054
Guidance	0.013	0.014	−0.010	0.047
Group constellation	0.020	0.019	−0.015	0.062
Engagement	0.0122	0.042	0.044	0.205
Contribution	−0.020	0.010	−0.045	−0.052
Assessment quality	0.005	0.009	−0.010	0.025
Task characteristics	0.064	0.023	0.025	0.116
Structuring	0.039	0.016	0.015	0.080
Guidance	0.025	0.013	0.006	0.057
Group constellation	0.051	0.022	0.016	0.106