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Enacting control with student dashboards: The role of motivation

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Abstract

Background: Even though monitoring and control enactment are key aspects of self-regulated learning (SRL), Adaptive learning technologies (ALTs) may reduce the need for learners to monitor and control their learning. Personalized dashboards are effective in supporting learners' monitoring and can potentially support control behaviour. Allowing learners to enact control over their learning process, seems to hold potential for increasing their motivation.

Objectives: Therefore, this study's aim was to investigate the relation between control enactment and motivation. We examined how learners enacted control while learning with an ALT with personalized dashboards and examined the relation between learners' enactment of control and their motivation.

Methods: Seventy-eight primary school learners (Grade 5) participated. During the lesson, learners worked on mathematics in the ALT and concurrently were shown personalized visualizations that supported monitoring and enacting control over their learning process. Learners could enact control to change problems' difficulty to easy, medium, or hard. Motivation was measured before and after learning.

Results: The SEM analyses showed that how learners enacted control was related to their motivation. Choosing difficult problems was related to more enjoyment and competence while choosing easy problems related to more pressure and tension. Learners who complied with the suggested difficulty level experienced less choice, but also less pressure/tension and more enjoyment and competence.

Conclusions: These results provide avenues to account for broader learner characteristics like SRL and motivation to optimize learning. This way, hybrid systems in which control enactment is a shared responsibility of the system and learner, can be improved to support SRL development.

KEYWORDS
adaptive learning technologies, dashboards, K-12, motivation, self-regulated learning

1 | INTRODUCTION

Self-regulated learning (SRL) is essential for (academic) achievement (Zimmerman, 2000). Monitor and control enactment are key aspects of SRL (van Merriënboer & de Bruin, 2019; Veenman, 2013) and young learners need assistance developing these skills. While adaptive learning technologies (ALTs) are effective in fostering math performance in primary education (Molenaar et al., 2017), they may also reduce the need for learners to monitor and control their learning as ALTs support personalized learning by diagnosing learners' ability level and adjusting the difficulty of problems accordingly. Thus, this type of task adaptivity may minimize opportunities to develop SRL skills (Molenaar, 2022). Previously, research already showed that personalized dashboards are effective in supporting learners' monitoring behaviour (Molenaar et al., 2020, 2021). In addition, dashboards potentially can also support control behaviour. Allowing learners to enact control over their learning process, could positively affect their motivation (Jansen et al., 2016). This way learners' metacognitive activities (monitoring and control enactment) and motivation for the tasks may enhance each other. However, whether learners enact control in ALTs when given the opportunity and whether this relates to their motivation remains to be investigated. Therefore, the overall aim of the present study was to understand the relation between control enactment and motivation. In this design study it was examined (i) to what extent young learners enact control while practicing in an ALT with personalized dashboards and (ii) the relation between learners' enactment of control and their motivation.

1.1 | SRL in ALTs

SRL is important for achieving (academic) success (Zimmerman, 2000). SRL theory defines learning as a goal-oriented process, in which learners work towards their learning goals by making choices (Zimmerman, 2000). Monitoring and controlling are two important processes in SRL (van Merriënboer & de Bruin, 2019; Veenman, 2013). In the COPES model, learners' internal regulation process with control and monitoring is highlighted (Winne & Hadwin, 1998). Learners with strong SRL skills engage in metacognitive activities, such as planning and monitoring, and demonstrate an adequate level of effort while learning compared to learners with weak SRL skills (Greene & Azevedo, 2007; Hadwin, 2011; Roll & Winne, 2015). During learning, learners consider available information about their performance and asses their progress in learning, which is called monitoring (De Bruin et al., 2017). These assessments drive strategic adjustments of learning behaviour when needed, which is called control (De Bruin et al., 2017; Molenaar et al., 2019, 2020). Hence, monitor and control enactment are cyclically connected and have a reciprocal influence on one another (van Merriënboer & de Bruin, 2019).

When learners practice in an ALT, the algorithm partially takes over this monitor-and-control loop (Molenaar et al., 2019) as it estimates learners' ability level and selects the next appropriate problem accordingly (Molenaar et al., 2019). These automatic adaptations to learner's ability, potentially prevents learners to engage in SRL themselves, because monitoring and control are executed by the ALT (Aleven et al., 2016). Although young learners may benefit from personalized support as provided with these algorithms, they also need the opportunity to practice and develop their SRL skills to be able to become effective self-regulated learners.

To support learners' monitoring, Molenaar and colleagues used learners' data to visualize how learners regulated their learning over time (Molenaar et al., 2019, 2020, 2021). Such personalized dashboards depict learners' learning process during practicing and helped learners to improve the efficiency of practice behaviour and reach higher accuracy on intermediate learning goals (Molenaar et al., 2020, 2021). This research showed that personalized dashboards in ALTs can improve learners' monitor behaviour (Molenaar et al., 2020, 2021).

In addition to monitoring, opportunities for learners to enact control over learning behaviour is important to enhance SRL (van Merriënboer & de Bruin, 2019; Veenman, 2013). Enabling learners to execute control over their practice behaviour can be accomplished by providing them with the opportunity to select problems (De Bruin et al., 2017; Molenaar et al., 2019, 2020). Previous research indicates that increased control opportunities can optimize learning (Corbalan et al., 2006; Long & Aleven, 2016). When learners were allowed to enact control by selecting the difficulty of the problems, they learned more than learners who received system-selected problems (Long & Aleven, 2016). In a similar vein, Corbalan et al. (2006) showed that when learners in a technology-enhanced learning environment were allowed to select problems from a preselected subset, their learning improved compared to learners without control. Providing learners with the opportunity to enact control over problems thus seems to be beneficial for learning.

Next to improving the learning outcomes, providing the opportunity to enact control seems to be the feature that enables shared regulation and supports SRL skills. Personalization of learning has primarily been directed at diagnosing learners' cognitive abilities, in order to adjust learning materials to improve learning outcomes (Molenaar et al., 2021). However, personalized learning can also be used to diagnose and develop learners' SRL (Azevedo et al., 2010; Bannert et al., 2009). A new way to enhance learners SRL is proposed in the concept of Hybrid Human-AI Regulation (HHAIR; Molenaar, 2022). Within HHAIR forward adaptive support for SRL is developed that aims to improve learners' SRL skills. In order to do so, HHAIR proposes that regulation is conceptualized as a shared task between the learner and the ALT. Depending on learners' SRL skills, the system can take over regulation or transfer regulation back to the learner (Molenaar, 2022). In such a system, two components are essential: an algorithm that can detect SRL and adjust support to the learner' SRL skills and a dashboard in which learners can view how they monitor and control their learning process. Such a system cannot detect and support the whole range of SRL yet, but a start has been made in the Learning Path App (LPA) by detecting correct scores and supporting control enactment (Molenaar et al., 2019).

In the LPA, learners' learning process is visualized in personalized dashboards, hence a reference for learners to improve monitoring. Consequently, improved monitoring can drive adjustment of strategies and actions, but only when learners can in fact execute control (Molenaar et al., 2020). Therefore, learners were given the possibility to select the probability that they will answer the next problem correctly (also called the difficulty level of the problems). Typically, the default probability setting is set at to 75% chance that the learner will answer the next problem correctly (Klinkenberg et al., 2011). Different studies have previously given learners the opportunity to select easier (85%), medium (75%) or more difficult problems (65%) (Jansen et al., 2013). This allows learners to act upon their monitoring and enact control by adjusting the difficulty level of the problems to achieve their previously set learning goals. Therefore, it is possible to build a feature enabling enactment of control. However, this does not mean that learner enact control; they might need support.

Indeed, previous research also indicates that learners determine the difficulty level based on a diverse set of perceptions such as math anxiety (Schmitz et al., 2019) and may need support to enact control. Scaffolding refers to supporting learners according to their needs and talents, providing them with support in tasks they cannot yet (sufficiently) perform themselves (Hmelo-Silver & Azevedo, 2006; Wood et al., 1976). Previous research has shown that scaffolds can support SRL (Azevedo et al., 2004; Bannert et al., 2009; Molenaar et al., 2012). Hence scaffolds can help support learners to select the difficulty level that fits best the current learning process of the learner. Related research showed that learners act upon (follow) scaffolds provided in the LPA (Horvers et al., submitted). Hence the LPA's scaffolds support learners (monitoring) in deciding whether they should increase or decrease the difficulty level of problems. This way scaffolds help learners to enact control and when learners follow the suggestions from the scaffold, we speak of compliance.

Thus, research has shown the relation between control enactment and learning, and technological advancement has made it possible to enable and support control enactment. However, to further understand and support learners' control enactment, individual differences between them should be investigated. One potential source of individual differences, which is central in theoretical models of SRL is motivation (Efklides et al., 2017).

1.2 | The role of motivation in enactment of SRL

Theoretical models of SRL emphasize the role of motivation (Efklides et al., 2017). Motivation is directly related to effort, i.e., learners' commitment to achieve learning goals. As such, motivation is an important aspect that determines how learners practice math problems. Especially in an HHAIR system where control is transferred back to learners; motivation to enact control over their learning process is important.

Motivation in education can be conceptualized by means of the self-determination theory (Deci & Ryan, 2008; Ryan & Deci, 2000, 2009). This theory assumes that autonomy and competence function as the main drivers of motivated behaviour. Motivation can be split into intrinsic and extrinsic motivation. Intrinsic motivation comes from within a person. Intrinsically motivated learners are motivated for and engage in tasks because they experience the activities as interesting or enjoyable. These learners experience autonomy during the tasks they fulfil (Ryan & Deci, 2000). Intrinsic motivation is considered the most optimal form of motivation for learning (Vansteenkiste et al., 2009).

Extrinsic motivation arises from an external source and occurs when the performance of a task is steered by external factors such as rewards, expectations, or punishment (Vansteenkiste et al., 2006). The least autonomous form of extrinsic motivation is the externally regulated motivation, where learners pursue tasks because of the rewards or punishments present in the environment. Learners feel that they have no choice or say in the tasks they have to perform. Next, introjected regulation refers to unconsciously embedded rules and interests, i.e., learners' study to score well in comparison with other learners, to be proud, or to avoid guild. A more internalized form of extrinsic motivation, where learners recognize that performing the activity is personally relevant, is identified regulated motivation (Vansteenkiste et al., 2007).

Learners' motivation is often measured after practice to indicate their motivation towards learning to explain variation in learning processes between learners. Learners are asked to report on their experience related to the tasks such as perceived choice, enjoyment/interest, and pressure/tension (see also CSDT, 2022; McAuley et al., 1989; Waterschoot et al., 2019). However, a learner's personal motivational system may affect one's perceived enjoyment or pressure after a task (independent of that task). According to the motivation theory, intrinsically motivated learners are more likely to derive pleasure from tasks, while extrinsically motivated learners are more likely to experience pressure to accomplish them (Ryan & Deci, 2000). In experimental studies, a pre-measurement is rarely included (e.g., Meng & Ma, 2015; Waterschoot et al., 2019), possibly as randomization eliminates motivational differences between control and experimental groups. However, a pre- and post-design has its benefits to highlight the more complex relation between motivation and practice behaviour in individual learners. Previous research has shown that the extent to which learners experiences autonomy can affect how they approach and experience a task. A wide range of studies without ALTs suggests that giving learners choice indeed stimulate their motivation (e.g., Meng & Ma, 2015; Patall et al., 2010; Waterschoot et al., 2019). In a lab experiment in which learners had to accomplish time-estimate tasks (estimating how long certain stimuli appeared on a screen), adults who were provided with the opportunity to choose between two tasks, were more intrinsically motivated and experienced more enjoyment (Meng & Ma, 2015). The same effect is visible in providing choice to children, e.g., Waterschoot et al. (2019) found that children who received choice in the creative activity they had to participate in, experienced more autonomy and enjoyment of and interest in the task. Also in secondary school learners, providing different homework options led to higher intrinsic motivation for schoolwork and a feeling of competence, compared to learners who did not receive choices

(Patall et al., 2010). Whereas enjoyment, interest and perceived competence are positive aspects of choice, pressure or tension can be regarded as their negative counterparts (Leng et al., 2010).

Next to choice, also perceived task difficulty was found to be related to learners' motivational response for the given task. Learners who perceived their tasks as more difficult were likely to indicate lower levels of interest and enjoyment (Li et al., 2007). Ahmed et al. (2010) showed that demanding tasks can also hinder learners' motivation, resulting in lower interest and enjoyment (Fulmer & Frijters, 2011). Providing learners with the opportunity to adjust the difficulty level of the problems to fit their personal needs, thus seem to hold potential for increasing their motivation. Therefore, it is important to understand the relation between motivation and control enactment when learning with an ALT.

Although ALTs generally select problems for learners, there are systems that allow learners to indicate preference and choices. Papoušek and Pelánek (2017) examined providing choice to learners who practiced geography in an ALT. They showed that learners who selected difficult problems, were more engaged in the task (Papoušek & Pelánek, 2017). When primary school children were given the opportunity to modify the problems' difficulty level (Jansen et al., 2016), and could choose between easy, medium, or hard problems, learners that modified the difficulty level more frequently had a higher math ability. The direction of changes was also related to the math ability: higher ability related to a preference for more difficult problems. Jansen and colleagues did not find difference regarding the amount of practice behaviour between that learners' who were allowed to choose their difficultly level and the ones assigned to one. In contrast to the studies reported above, choice did not lead to a higher motivation to practice more. Jansen et al. (2016), however, did not explicitly measure (various aspects of) motivation and focused more on learning behaviour and learning outcomes. Exploring and mapping learners' motivation could provide more insight into their learning behaviour.

1.3 | Present study

When moving towards a hybrid system in which regulation of practice behaviour is a collaborative task between learner and system, understanding the relation between SRL, choice, and learners' motivation is essential. Current generations of ALTs support personalized learning by adapting the problems to learners' cognitive abilities. A recent development is to slowly transfer control over regulation back to learners, for example by allowing them to enact control by selecting the difficulty of the problems (HHAIR: Molenaar, 2022). Control enactment is likely to interact with learners' motivation. However, it remains to be investigated how motivation and control enactment interact. This information is needed to inform how enabling control enactment can improve learning outcomes and SRL skills. Therefore, the overall aim of the present study was to understand the relation between control enactment and motivation. Accordingly, it was examined to what extent young learners enact control while practicing in an ALT with personalized dashboards and the relation between learners' enactment of control and motivation. The research questions in this study were:

i. To what extent did learners engage in enactment of control?
ii. How was learners' enactment of control related to their motivation?

To answer our research questions, we logged learners' practice behaviour during learning. Learners' motivation was measured before and after learning. During learning, learners could monitor their practice behaviour in personalized dashboards. Learners enacted control by changing the difficulty level of problems to easy, medium or hard. Scaffolds were embedded in the dashboard to support learners in adjusting the difficulty level of problems. See Figure 1 for the study overview and design.

We expected that learners would indeed seize the opportunity to engage in control enactment during learning by changing the difficult level and that they would do so according to the direction indicated by the scaffold on their personalized dashboards. In general, we expected that learners' engagement in control enactment and their compliance with the scaffolds is related to their motivation. However, due to the exploratory nature of this design study, no specific hypotheses were formulated. Based on the motivation theory discussed above, it is reasonable to assume that enactment of control and compliance with scaffolds are related to motivation, and we see it as desirable to study these relationships in a wide perspective.

2 | METHOD

2.1 | Participants

Participants were 78 Grade 5 learners in Dutch primary education from two schools (three classes). The learners were between 10 and 13 years old ($M_{age} = 10.05$, SD = 0.53 years, 45 girls and 33 boys). Only participants who participated in at least three out of four lessons were included in the study: nine participants were excluded.

2.2 | Design

This study was conducted with a quasi-experimental pre–post-test design (see Figure 1). Learners received instruction and practiced three arithmetic skills during three consecutive lessons of 55 min using an ALT. Learners were taught three different skills concerning fractions (see Section 2.3). In the fourth lesson, learners were given the opportunity to practice one or more of these skills. The pre-test addressed (intrinsic, introjected, identified, and extrinsic) motivation and knowledge about fractions, and was conducted before the first lesson (30 min). The post-test addressed motivation (interest/enjoyment, competence, perceived choice, and perceived pressure/tension) and knowledge about fractions and was conducted after completion of all lessons (30 min).

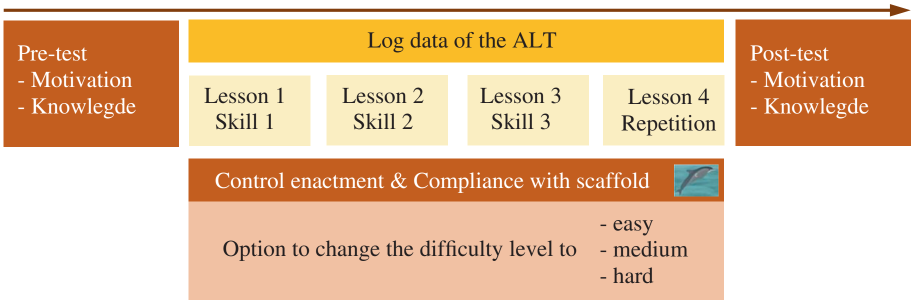


FIGURE 1 Study design.

2.3 | Materials

2.3.1 | Adaptive learning technology

The ALT used in this study (Gynzy®) is used in primary education (Grade 1–6) throughout the Netherlands. Gynzy is used to practice various subjects on tablets, e.g., math, spelling, language, and vocabulary. This ALT is applied in hybrid classrooms: typically, the teacher provides instruction first, after which learners practice individually on tablets.

The ALT selects problems based on an estimate of learners' current knowledge, i.e., skill level (Corbett & Anderson, 1995). Learners' skill level is calculated by a derivative of the ELO algorithm (Elo, 1978; Klinkenberg et al., 2011). Based on this skill level, the ALT selects problems by using a 75% probability that the learner will solve this problem correctly (Aleven et al., 2016; Elo, 1978; Klinkenberg et al., 2011). The ALT selects from a pool of problems which, based on the topic/skill/learning goal, can range in size between 50 and 300 exercises.

Directly after each problem, learners receive feedback (correct/incorrect). If the problem is not solved correctly the first time, the learner gets a second attempt. After 12 consecutive adaptive problems, learners see their scores (the number of correct and incorrect answers) in the intermediate overview screen. This is the standard operating process in Gynzy. See Molenaar et al. (2020) for more detailed information on the ALT. In Figure 2, four screenshots of the ALT are shown: an assignment during individual practice, direct feedback on an incorrect answer and direct feedback on a correct answer, and the intermediate overview screen on which students see their intermediate scores from the last 12 assignments.

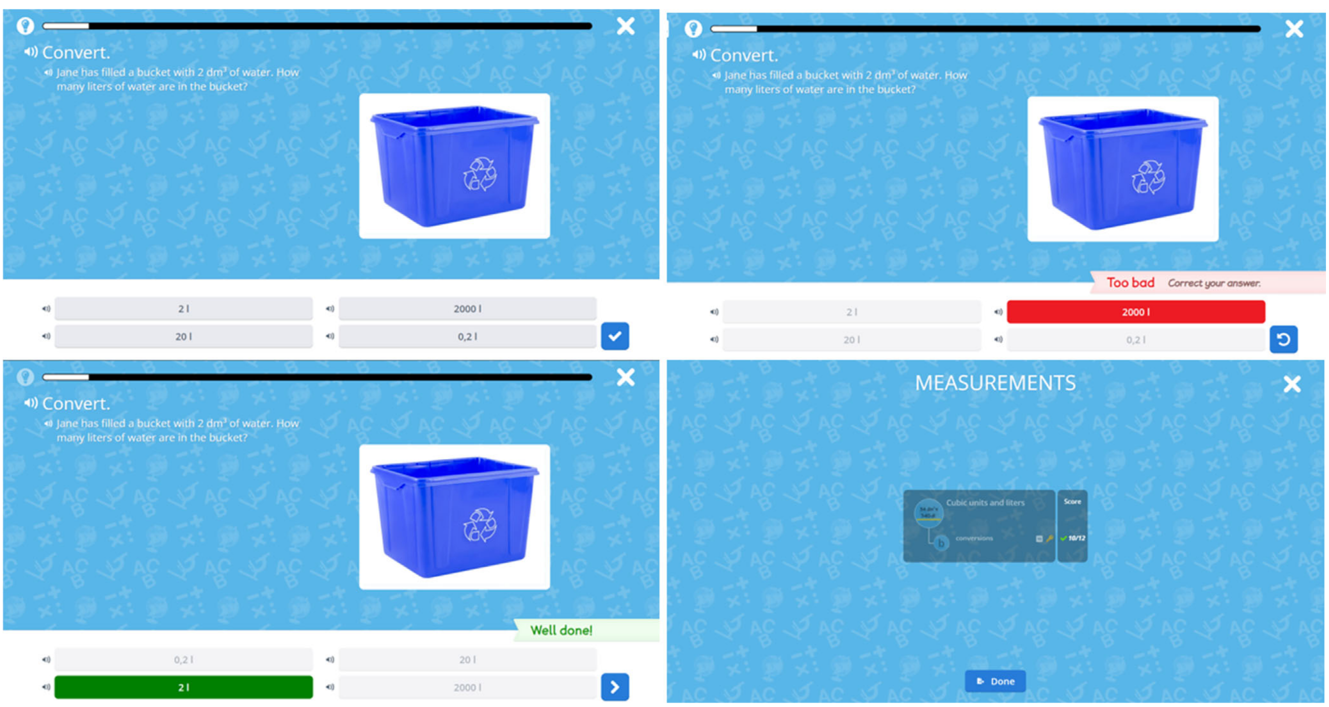


FIGURE 2 Example assignment (top left), direct feedback screen after an incorrect (top right) and correct answer (bottom left), the intermediate overview screen (bottom right).

2.3.2 | Lessons content

During the lessons, learners practiced with three math skills (see Table 1). The topic was fractions and the difficulty increased over the lessons. The first skill, 'simplifying basic fractions', was relatively easy, due to the use of basic fractions. The second skill, 'simplifying mixed fractions', was of medium difficulty. The last skill, 'simplifying complex fractions', was difficult due to the use of large numbers and complicated fractions.

2.3.3 | Learning path app

While practicing in the ALT, learners received support via the Learning path app (LPA). The LPA was shown on a separate device on learners' tablet and was digitally connected to the ALT. The LPA showed three personalized screens (see Figure 3) that supported learners in monitoring and enact control over their learning process.

The LPA included a goal setting screen and an overview screen. These screens provided information on learners' progress while practicing (monitoring) and in the overview screen learners could enact control by selecting the difficult level of the problems (control enactment).

Before practicing and after initial instruction in the classroom, learners set their own goals in goal setting screen. On this screen, learners indicated how proficient they aimed to become at that skill (ultimate goal) and their goal for this particular lesson (goal after the lesson). They did so by moving a flag on a scale (0%–100%), which indicated the ability level in Gynzy they wanted to achieve. During practicing, they could revisit this screen and were shown how they progressed towards their flags (see filled in bars in Figure 3).

TABLE 1 Skills and example problems.

Skills	Difficulty classification	Example
Skill 1: Simplifying basic fractions	Easy	$\frac{5}{10}=\frac{1}{2}$
Skill 2: Simplifying mixed fractions	Medium	$\frac{17}{10}=1\frac{7}{10}$
Skill 3: Simplifying complex fractions	Hard	$\frac{42}{21}=\frac{2}{1}=2$

In the overview screen, three dolphins depicted learner's practice behaviour on the three skills. The colour of the dolphin showed the progress towards their own set learning goal (green: goal achieved, orange: progress towards goal, grey: goal not yet set). The size of the dolphin increased when more problems were made. The horizontal position of the dolphin on the screen showed the ability level (more to the right, higher ability score). The angle of the dolphin showed a learner's growth towards their goal.

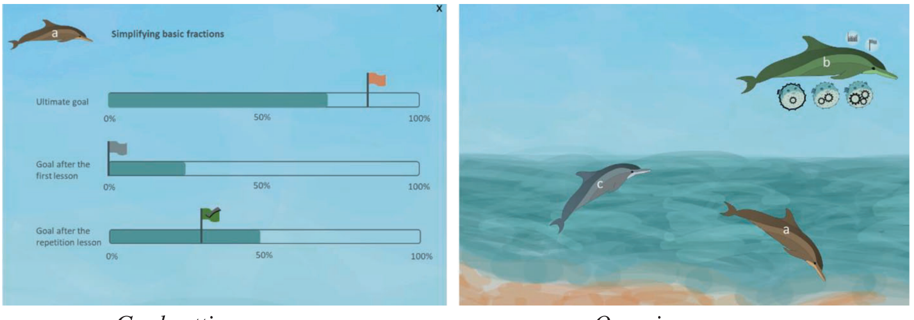
Learners were instructed that after the intermediate overview screen in Gynzy was shown (so after 12 problems), they should go to the LPA, inspect their dolphin, and if desired alter their difficulty level. Learners could use the angle of the dolphin (ascending, stable, or descending) as advice to adjust the difficult level of the next problems, which was also explained in the instruction. During practicing, learners could unrestrictedly enact control by changing the difficulty level of the ALT. However, they were prompted to go to the LPA after 12 consecutive problems were finished.

By choosing the easy, medium, or hard pufferfish (below each dolphin), learners increased or decreased the probability that they would answer the problem correctly by 10%. Typically, the ALT is set to a probability of 75% chance that the learner answers the problems correctly. By changing this probability to 85% (decrease difficulty level), a learner had a higher chance of answering the problems correctly (on average the problems will be easier for the learner). By selecting the medium level (75%) difficulty did not change. By changing it to 65% (increase difficulty level), the chance of answering correctly decreased (on average the problems will be harder for the learner). When no difficulty level was chosen, the difficulty did not change.

Based on recorded log files, we determined the number of changes made per lesson and the direction of changes. Data was aggregated over the three skills and 4 days.

2.3.4 | Enactment of control

Enactment of control was measured as the number of changes to the difficulty level participants made. This measure was further specified into three measures: change level to more difficult, do not change the difficulty level, and change level to easier. Learners could always change the difficulty level during practice in the overview screen but were prompted to do so after 12 consecutive problems. Therefore, a maximum score could not be identified beforehand.



Goal setting screen *Overview screen*

FIGURE 3 Screens of the LPA.

2.3.5 | Compliance with scaffold

The angle of the dolphin in the overview screen was used as the scaffold in this design study: when the dolphin pointed upwards, the advice was to increase the difficulty level, when the dolphin pointed downward, the advice was to decrease the difficulty level: when the dolphin swam horizontally, the scaffold indicated to keep the difficulty level constant (no change recommended). Learners were instructed about the meaning of the dolphins. Compliance was measured as the number of changes to the difficulty level learners made that were in line with the scaffold. This measure was further specified into three measures: change level to more difficult than suggested, change the level of difficulty in line with the scaffold, and change level to easier than suggested.

2.3.6 | Motivation

Pre-test

Motivation prior to learning was measured using the Academic Self-regulated learning Scale (Ryan & Connell, 1989) as translated by Vansteenkiste et al. (2009). The scales intrinsic, introjected, identified, and extrinsic motivation were filled. The questionnaire had 16 items in total and was constructed to measure four aspects of motivation (each with four items): intrinsic, extrinsic, identified, and introjected. Learners responded on a five-point Likert scale (score 1–5). All items were phrased positively, meaning that a higher score meant more motivation.

To verify the structure of the motivation questionnaire, we conducted a Principal Component Analysis with varimax rotation. The first PCA with four components revealed item loadings that were overall in line with the four subscales, but there were three inconsistent loadings. Furthermore, the introjected motivation subscale was not reliable, $\alpha = 0.43$, $\lambda_2 = 0.48$, which could not be resolved by removing items. Therefore, a second PCA was conducted with three components, excluding introjected motivation. The results showed that intrinsic, identified, and extrinsic motivation items loaded on their own component, with loadings larger than 0.50. There was one exception: the third item of the intrinsic motivation subscale, which cross-loaded on all three components. Since one of the loadings of this item was on the intrinsic motivation subscale, we regarded the second PCA as a verification of three subscales.

The three subscales were reliable: intrinsic, $\alpha = 0.80$, $\lambda_2 = 0.83$, identified, $\alpha = 0.66$, $\lambda_2 = 0.66$, and extrinsic motivation, $\alpha = 0.61$, $\lambda_2 = 0.62$. We proceeded analyses with averaged scores of these three subscales. Thus, scores ranged from 1 (no motivation) to 5 (maximum motivation).

Post-test

Motivation after learning was measured with the Intrinsic Motivation Inventory (IMI) (Ryan, 1982; Waterschoot et al., 2019). The scales interest/enjoyment, perceived competence, perceived choice, and perceived pressure/tension were filled in. The questionnaire had 22 items in total and was constructed to measure four aspects of motivation: interest/enjoyment (seven items), competence (five items), perceived choice (five items), and perceived pressure/tension (five items). Participants responded on a five-point Likert scale (score 1–5). Some items were phrased negatively. We recoded these items to have higher scores mean more motivation.

To verify the structure of the motivation questionnaire, we conducted a Principal Component Analysis with varimax rotation. The first PCA with four components revealed that interest/enjoyment and competence loaded on the same component. Therefore, a second PCA was conducted with three components. The results showed that (1) interest/enjoyment and competence, (2) perceived choice and (3) pressure/tension each loaded one component, with loading larger than 0.50. There was one exception: the fifth item of the perceived choice subscale, which showed loadings smaller than 0.30. Since this item did not load on a particular component, we regarded the second PCA as a verification of three subscales.

The subscales were reliable: interest/enjoyment and competence, $\alpha = 0.95$, $\lambda_2 = 0.95$, perceived choice, $\alpha = 0.75$, $\lambda_2 = 0.76$, and pressure/tension, $\alpha = 0.77$, $\lambda_2 = 0.78$. Therefore, we proceeded analyses with averaged scores of these three subscales. Thus, scores ranged from 1 (no motivation) to 5 (maximum motivation).

2.4 | Data analysis

Mplus was used to conduct the SEM analyses (Muthén & Muthén, 1998–2017). The so-called path models were specified, meaning all possible paths are specified (similar to a regression, where all variables are entered into the model). Maximum Likelihood estimation with Robust standard errors (MLR) was used to adjust for deviations from normal distributions (see the skewness and kurtosis in Table 2 – Results). Indirect effects were explicitly tested by multiplying the respective paths.

We determined how to model the count variables before presenting the results. Count variables were the measures of enactment of control (change to a more difficult level, no change, change to an easier level) and compliance (changing to a more difficult level than suggested, changing difficulty in line with the scaffold, and changing to an easier level than suggested). In line with Greene et al. (2011), we inspected four types: regular paths (OLS), Poisson (P), negative-binominal (NB), zero-inflated Poisson (ZIP), and zero-inflated negative binominal (ZINB) (see Appendix 1: Tables A1 and A2). In both cases (enactment of control and compliance data), the BIC supported the P model as the best fit to the data, whereas the AIC and the SABIC supported the ZIP. The estimates did not differ substantially between the P and the ZIP model. Therefore, we accepted the ZIP model as the best fit for the data and reported the results of that model in the result section. Notably, all the count models (P, NB, ZIP, and ZINB) were a better fit, on each metric, than the OLS model.

TABLE 2 Descriptive statistics.

		M	SD	Min.	Max.	Skewness	Kurtosis
Control enactment	Total	3.12	2.04	0	11	1.21	2.53
	Easy	0.87	1.01	0	4	0.93	0.00
	Medium	0.44	0.78	0	4	2.07	5.02
	Hard	1.20	1.18	0	4	0.50	−1.11
Compliance with scaffold	Total	3.12	2.04	0	11	1.21	2.53
	No, easier than scaffold	1.27	1.46	0	6	1.01	0.33
	Yes, like scaffold	1.22	1.13	0	4	0.48	−0.97
	No, harder than scaffold	0.63	0.93	0	4	1.54	1.95
Motivation pre-test	Intrinsic	3.36	0.93	1.25	5	−0.30	−0.51
	Identified	4.16	0.65	2.50	5	−0.67	−0.39
	Extrinsic	2.84	0.84	1	4.75	−0.25	−0.77
Motivation post-test	Perceived choice	3.17	0.88	1.80	5.80	0.59	−0.04
	Pressure/tension	2.90	0.93	1.80	5.40	1.05	0.52
	Interest/enjoyment & competence	4.12	0.95	1.17	5.08	−1.67	1.97

3 | RESULTS

3.1 | Descriptive statistics

In Table 2, the descriptive statistics of enactment of control, compliance with scaffold, and motivation (pre- and post-test) are presented.

In Table 3, correlations between enactment of control, compliance with scaffold, and motivation (pre-test and post-test) are presented.

3.2 | The extent to which learners engaged in enactment of control

As shown in Table 2, learners adjusted the difficulty level of the problems on average 3.12 times during the four lessons (just below one time per lesson). The average of 3.12 was significantly larger than 0, $t(68) = 12.69$, $p < 0.001$, 95% CI [2.63, 3.61]. In 28% of the time, learners changed the difficulty level to easier problems, 13% to medium problems, and most of the times (39%), learners changed the difficulty level to more difficult problems.

When changing the difficulty level of the problems, learners complied with the scaffold 39% of the times: they adjusted the difficulty level in accordance with the advice from the scaffold. Equally frequently, they set the difficulty level to easier problems than suggested (41%). In 20% of the instances, learners adjusted the difficulty level to more difficult problems than was suggested.

3.3 | The relation between learners' enactment of control and their motivation

The model of enactment of control is depicted in Figure 4, paths that are not presented in the figure were non-significant, but still specified (see Appendix 2: Table A3 for all relations).

There were two relations between motivation prior to learning and the number of changes learners made during learning. There was a negative relation between identified motivation and the number of times learners decreased the difficult level: learners with higher identified motivation were less likely to decrease the difficult level. There was a positive relation between intrinsic motivation and the number of times learners increased the difficult level: learners with higher intrinsic motivation were more likely to increase the difficult level.

There were three associations between enactment of control during learning and motivation after learning. There was a positive relation between the number of times learners decreased the difficulty level and the extent to which learners experienced pressure/tension: learners who decreased the difficulty level were more likely to have experienced pressure/tension. There was a negative relation between the number of times learners increased the difficulty level and the extent to which learners perceived choice: learners who increased the difficult level were less likely to have experienced choice. There was also a positive relation between the number of times learners increased the difficulty level and the extent to which learners experienced interest/enjoyment & competence: learners who increased the difficulty level were more interested in and enjoyed the lessons more.

Finally, there were associations between motivation prior and after learning. Identified motivation was negatively related to perceived pressure/tension. Extrinsic motivation was positively related to perceived choice and negatively related to interest/enjoyment and competence. Possible indirect effects were not significant (see Appendix 2: Table A3).

3.4 | The relation between learners' compliance with the scaffold and their motivation

The model of enactment of control is depicted in Figure 5, paths that are not presented were non-significant, but still specified (see Appendix 3: Table A4 for all relations).

TABLE 3 Correlations.

			CE1	CE2	CE3	CS1	CS2	CS3	Mpr1	Mpr2	Mpr3	Mpo1	Mpo2	Mpo3
Control enactment	CE1	Easy												
	CE2	Medium	0.48***											
	CE3	Hard	−0.21	−0.01										
Compliance with scaffold	CS1	No, easier than scaffold	0.70***	0.62***	−0.30*									
	CS2	Yes, like scaffold	0.06	0.04	0.69***	−0.18								
	CS3	No, harder than scaffold	0.08	0.31*	0.52***	−0.02	0.16							
Motivation pre-test	Mpr1	Intrinsic	−0.04	−0.09	0.28	−0.23	0.21	0.35						
	Mpr2	Identified	−0.22	−0.22	−0.06	−0.21	0.05	−0.15	0.32**					
	Mpr3	Extrinsic	0.00	0.03	−0.08	−0.01	0.03	−0.21	−0.22	−0.14				
Motivation post-test	Mpo1	Perceived choice	0.05	−0.02	−0.18	0.07	−0.17	−0.10	0.01	−0.10	0.29*			
	Mpo2	Pressure/tension	0.27*	−0.04	−0.20	0.13	−0.19	−0.03	0.01	−0.22	0.13	0.51***		
	Mpo3	Interest/enjoyment & competence	−0.24*	−0.04	0.32**	−0.14	0.18	0.09	0.04	0.13	−0.23	−0.68***	−0.51***	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

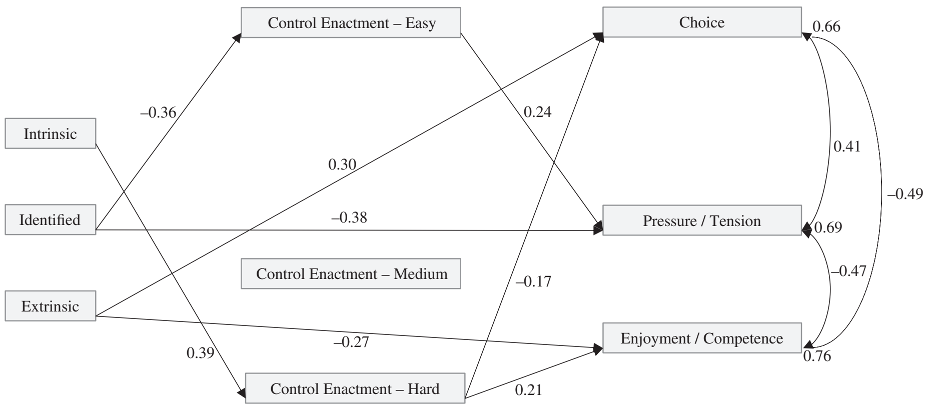


FIGURE 4 Model of enactment of control. *Note*: Only significant paths are shown, see Appendix 2: Table A3 for all path coefficients and their *p*-values.

There were three relations between motivation prior to learning and the compliance with the scaffold. There was a positive relation between intrinsic motivation and both the number of times learners changed the difficulty level in compliance with the scaffold and number of times learners changed the difficulty level to more difficult than advised by the scaffold: learners with higher intrinsic motivation were more likely to comply with the scaffold and to increase the difficulty level to more difficult than advised. There was a negative relation between identified motivation and number of times learners changed the difficulty level to more difficult than advised by the scaffold: learners with higher identified motivation were less likely to increase the difficulty level to more difficult than advised.

There were three associations between compliance of the control enactment during learning and motivation after learning. There was a negative relation between the number of times learners changed the difficulty level in compliance with the scaffold and the extent learners perceived choice and experienced pressure/tension: learners who changed the difficulty level in accordance with the scaffold, were less likely to have perceived choice and have experienced pressure/tension. There also was a positive relation between the number of times learners changed the difficulty level in compliance with the scaffold and learners' experienced interest/enjoyment and competence: learners who complied to the scaffold were more interested in and enjoyed the lessons more.

Finally, there were associations between motivation prior and after learning. Extrinsic motivation was positively related to perceived choice and negatively related to interest/enjoyment & competence. Possible indirect effects were not significant (see Appendix 3: Table A4).

4 | DISCUSSION

The overall aim of the present study was to understand the relation between control enactment and motivation in young learners (grade 5) in an ALT. The results showed that learners engaged in enactment of control, and that there was a large variation in both enactment of control and which difficultly level was selected. On average, learners changed the difficulty level of problems a little less than once per lesson. Learners complied with the scaffold, thus changed difficulty as suggested, less than half of the time. Two patterns emerged from the data: First, intrinsically motivated learners were more likely to increase the difficulty level and to make it harder than suggested by the scaffold. Learners who increased the difficulty level felt more enjoyment and competence, and less pressure and tension. The second pattern was that learners with higher identified motivation decreased the difficulty level, and experienced tension and pressure afterwards.

4.1 | Enactment of control

As expected, learners engaged in control enactment during learning by changing the difficultly level of the problems. Learners changed the difficulty level of problems approximately once per lesson, mostly to more difficult problems. Some learners changed the difficulty level up to 11 times, confirming the findings of Jansen et al. (2016) that there was variation between learners in the amount and direction of their control enactment. Thus, learners used the opportunity to adjust the difficulty and they did so in varying extents.

Learners complied with the scaffold, thus changed difficulty as suggested, in 39% of the time, and equally often set the difficulty level easier than advised. Possibly some learners preferred to practice with easier problems as it could result in more positive reinforcement by the ALT. Learners may have thus ignored the 'more difficult' advice from the scaffold. When learners are not accustomed to being offered (extra) difficult problems, they may not feel confident to try such difficult problems (Gallaher & Pearson, 2000) even when the scaffold suggests them.

4.2 | Enactment of control and motivation

In line with our expectations, learners' engagement in control enactment was related to their motivation. Learners with identified motivation more often chose easy problems, while intrinsically motivated learners chose difficult problems.

Learners with identified motivation are characterized by a motivation steered towards external factors such as rewards, expectations,

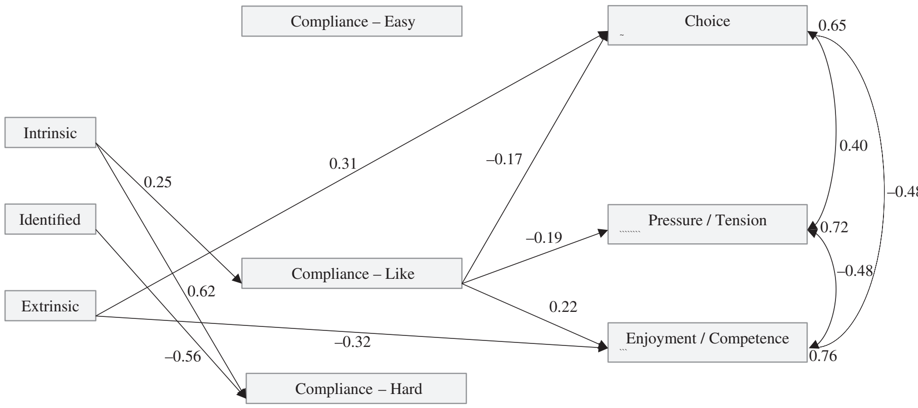


FIGURE 5 Model of compliance.
Note: Only significant paths are shown, see the Appendix 3: Table A4 for all path coefficients and their *p*-values.

or punishment, while they do recognize that performing the activity is personally relevant (Vansteenkiste et al., 2007). There was positive reinforcement (i.e., a reward) in our ALT when a problem was solved correctly. By working with an easier difficulty level, learners can answer more problems correctly. This would disregard the idea of practicing within the zone of proximal development (Vygotsky, 1978). It might, therefore, be recommended to learners with identified motivation to practice difficult problems, when they are ready for it. In other words, urge them to comply with the scaffolds.

Intrinsically motivated learners are inclined to be motivated for and engaged in tasks because they experience the activities as interesting or enjoyable in itself (Ryan & Deci, 2000). Indeed, in the present study, we found that these learners enact control by selecting more difficult problems and that learners who do so enjoy the lessons and feel competent practicing. This confirms earlier studies which demonstrated that providing choice related positively to intrinsic motivation (Cordova & Lepper, 1996; Waterschoot et al., 2019). Due to their perceived choice, these learners might have had a positive learning experience. This is in line with Carroll and Loumidis (2001) who showed that competence and enjoyment are closely related. This supports the premise that intrinsic motivation may mediate this relationship (Ferrer-Caja & Weiss, 2000). As intrinsic motivation is considered the most optimal form of motivation for learning (Vansteenkiste et al., 2009), it is likely to be positively associated with learning outcomes.

Regarding extrinsic motivation, results showed that extrinsically motivated learners experienced choice during the lessons, while no relation with choice was found for intrinsically motivated learners. A possible explanation is that extrinsically motivated learners could have experienced selecting the difficulty level as an opportunity to receive rewards (Ryan & Deci, 2000). That is, extrinsic motivation is driven by external factors (Ryan & Deci, 2000). Therefore, the choice offered is more salient and the score on perceived choice higher. This is supported by Waterschoot et al. (2019), who found that providing choice to learners positively impacted their experienced autonomy and led to a higher appreciation of the task.

Learners who changed the difficulty level in accordance with the scaffold, were less likely to have perceived choice during practicing. This result might be explained by the design of our scaffolds. The scaffolds were designed to partially take over learners' control by providing a suggestion based on their performance. Complying with the scaffold, thus, may have lowered the sense of autonomy as learners who complied with the scaffold, perceived fewer choice opportunities. This is less desirable as the sense of choice and autonomy that learners experience, positively contributes to their engagement during learning (Corbalan et al., 2006; Long & Aleven, 2016). However, our learners were also more interested in the lessons and felt competent. Waterschoot et al. (2019) found that providing choice to learners positively impacted their experienced autonomy. Our learners may have perceived less choice because of the presence of the scaffold, but at the same time, this did not lead to negative learning experiences. So, there appears to be a balance between more choice and more enjoyment. Is there a need for increased choice, scaffolds should be disregarded. When the objective is more enjoyment and engagement, one should comply with the scaffolds. This indicates that scaffolds can have a differentiated effect on students' learning experience.

Taken together, our results show that learners differ in how they enact control, which is related to their motivation. It is important that a system adjusts to individual needs and talents, such as learners' motivation. Some learners might be able and motivated to enact control, while others struggle with it. Therefore, future systems should investigate the possibility of taking over control in particular situations and giving it back in other situations, leading to a so-called Hybrid Human AI Regulation system (Molenaar, 2022).

4.3 | Limitations and future research

Some limitations and suggestions for future research can be put forward. First, as the present study was a design study, no control group was included and with a limited number of participants. A follow-up study can include a control group, which would allow for investigating the effects of control enactment and motivation on learning outcomes (Corbalan et al., 2006; Long & Aleven, 2016). Such follow-up would also allow confirmation of the results in a larger population. However, we do expect similar results in larger samples because our constructs were reliably measured, and plausible associations were detected in our analyses.

Secondly, although aligned with the ALT used by the learners daily in the classroom, the LPA was new. At the start of the study, learners were introduced to the LPA for the first time. Therefore, there may have been a novelty effect (Sung et al., 2009) leading to more interaction with the system (enactment) and/or higher motivation (enjoyment). Furthermore, the intervention in the present study lasted 1 week. To effectively change learners' motivation, the length of an intervention should cover a longer period (Jansen et al., 2016). It is therefore recommended that in follow-up studies, the duration of the intervention be extended to a minimum of 6 weeks.

Third, learners reported in class that they liked that they could transform the dolphins by their own actions (e.g., making them bigger or changing their colour). Especially in extrinsically motivated learners, this could have triggered their need for positive rewards, which potentially made them more motivated to practice. While this effect is not reflected in the results, it does support the general conclusion that different aspects of motivation may be catered to differently (see e.g., Molenaar et al., 2020).

These findings are critical for the future development of interventions directed at increasing learners' ability to enact control in ALTs. We are only beginning to understand the complex interaction between SRL and motivation and future studies investigating these relations with trace data during learning are a powerful way to enhance this understanding. Future research could, for example, investigate learners' emotions during practice behaviour with trace data by skin conductance bracelets (Horvers et al., 2021) to map fluctuations in motivation during learning. This would allow for a more direct link towards control enactment.

In addition, to gain a broader developmental perspective on the relation between control enactment and motivation, research in secondary school learners would be recommended. These learners have more developed SRL skills (Raffaelli et al., 2005) and may show variation in their motivation for schoolwork due to declining motivation for their school during adolescence (Wigfield et al., 2006). Examining how motivation relates to their control enactment may provide opportunities to support both in this group.

The relation between control enactment and motivation in an ALT environment has been found to be complex, but also offers leads for further improvement of HHAIR systems. In learning environments where learner and system both actively contribute to the learning process, it seems advantageous to incorporate several types of support for learners with different types of motivation. By tailoring the system to the motivational needs of learners, for example, learners scoring low on identified motivation might start with an easy difficulty level leading to less perceived pressure, but then urge them to comply with the scaffolds to ensure that they do not practice with too easy problems. This also offers the possibility for research to investigate how behaviour interacts with monitoring and control.

4.4 | Practical implications

Providing learners with the opportunity to choose the difficulty level and thus empowering them to take ownership of their own learning process, can be achieved in a relatively simple way. Enabling them to work with the LPA in combination with their usual ALT provides them with monitor and control opportunities. The LPA facilitates the creation of shared responsibility for learners and the system. Currently, this is only possible on a limited scale within research settings. However, as many schools work with ALTs, teachers may share and discuss the information they have (provided by the ALT) about the learning process with learners. This way, teachers create monitor opportunities, and in addition, can support control enactment by actively involve learners in choice during the learning process (e.g., which and how many problems a learner makes). It is essential to offer monitor and enactment in conjunction, as learners can only make well-founded choices if they can monitor their learning process (van Merriënboer & de Bruin, 2019; Veenman, 2013).

Intrinsically and extrinsically motivated learners showed different patterns in the choices they made and the impact these choices had on their learning experience. In educational contexts, it is important to have an understanding and monitoring of the motivation of learners. It is possible that in the near future learning analytics may provide tools for teachers to support motivating learners based on learners' control enactment.

5 | CONCLUSIONS

It can be concluded that there is large variation in how learners enact control while working in an ALT and whether they comply to the presented scaffold. Learners differ in the number of changes made in the difficulty level of the problems as well as in the direction of changes reducing or increasing difficulty. Some learners barely enact control, while others do so multiple times per lesson. Motivation prior to learning has few relations with control enactment, although intrinsically motivated learners are more likely to choose more difficult problems, even when the scaffold did not suggest that. The direction of control enactment and motivation after learning shows clear patterns. In general, learners who chose more difficult problems experienced more enjoyment and competence, while learners choosing easy problems, experienced more pressure and tension. Learners who complied with the scaffold experienced less choice, but also less pressure and tension and more enjoyment and competence. These findings suggest a complex relationship between control enactment and learners' motivation, whereby not only the quantity of the choices is important, but also the direction. Our results provide avenues to account for broader learner characteristics like SRL and motivation to optimize learning.

AUTHOR CONTRIBUTIONS

Carolien A. N. Knoop-van Campen: Conceptualization; methodology; writing – original draft; writing – review and editing. **Joep van der Graaf:** Formal analysis; methodology; visualization; writing – original draft; writing – review and editing. **Anne Horvers:** Conceptualization; investigation; methodology; project administration; writing – review and editing. **Rianne Kooi:** Writing – review and editing. **Rick Dijkstra:** Data curation; methodology; software; writing – review and editing.

Inge Molenaar: Conceptualization; funding acquisition; methodology; project administration; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

Authors state that they have no conflict of interest.

PEER REVIEW

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/jcal.12936.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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APPENDIX 1

TABLE A1 Fit measures of the control of enactment model.

	AIC	BIC	SABIC
OLS	1068.105	1161.938	1029.659
P	989.346	**1076.476**	953.647
NB[a]	992.888	1086.720	954.442
ZIP	**988.902**	1082.735	**950.457**
ZINBa	994.907	1095.442	953.715

Note: Bold values indicate the best fit for the data.
[a]Estimation problems, non-positive definite first-order derivative product matrix.

TABLE A2 Fit measures of the compliance model.

	AIC	BIC	SABIC
OLS	1123.373	1217.205	1084.927
P	1048.317	**1135.447**	1012.617
NB[a]	1045.925	1139.757	1007.479
ZIP	**1041.655**	1135.487	**1003.209**
ZINBa	1047.399	1147.934	1006.207

Note: Bold values indicate the best fit for the data.
[a]Estimation problems, non-positive definite first-order derivative product matrix.

APPENDIX 2

TABLE A3 Model results of control enactment.

	Estimate	SE	Est./SE	*p*-Value
Motivation post-test – Perceived choice ON				
Motivation pre-test – Intrinsic	0.22	0.15	1.47	.140
Motivation pre-test – Identified	−0.24	0.18	−1.36	.172
Motivation pre-test – Extrinsic	0.30	0.12	2.54	.011
Control enactment – Easy	−0.01	0.12	−0.05	.961
Control enactment – Medium	−0.06	0.13	−0.47	.646
Control enactment – Hard	−0.17	0.09	−1.98	.047
Motivation post-test – Pressure/tension ON				
Motivation pre-test – Intrinsic	0.14	0.13	1.08	.283
Motivation pre-test – Identified	−0.38	0.20	−1.97	.049
Motivation pre-test – Extrinsic	0.13	0.10	1.34	.181
Control enactment – Easy	0.24	0.11	2.16	.031
Control enactment – Medium	−0.20	0.16	−1.29	.197
Control enactment – Hard	−0.15	0.08	−1.92	.055
Motivation post-test – Interest/enjoyment & competence ON				
Motivation pre-test – Intrinsic	−0.13	0.15	−0.91	.363
Motivation pre-test – Identified	0.23	0.24	0.97	.333
Motivation pre-test – Extrinsic	−0.27	0.13	−1.99	.047
Control enactment – Easy	−0.12	0.12	−1.06	.290
Control enactment – Medium	0.04	0.17	0.23	.819
Control enactment – Hard	0.21	0.09	2.42	.016
Control enactment – Easy ON				
Motivation pre-test – Intrinsic	0.04	0.16	0.27	.786
Motivation pre-test – Identified	−0.36	0.17	−2.14	.033
Motivation pre-test – Extrinsic	0.00	0.16	0.02	.985
Control enactment – Medium ON				
Motivation pre-test – Intrinsic	−0.07	0.18	−0.40	.690
Motivation pre-test – Identified	−0.66	0.45	−1.46	.144
Motivation pre-test – Extrinsic	−0.09	0.38	−0.23	.815
Control enactment – Hard ON				
Motivation pre-test – Intrinsic	0.39	0.14	2.82	.001
Motivation pre-test – Identified	−0.24	0.16	−1.49	.137
Motivation pre-test – Extrinsic	0.06	0.14	0.39	.698
Motivation post-test – Pressure/tension WITH				
Motivation post-test – Perceived choice	0.41	0.12	3.41	.001
Motivation post-test – Interest/enjoyment & competence WITH				
Motivation post-test – Perceived choice	−0.49	0.14	−3.46	.001
Motivation post-test – Pressure/tension	−0.47	0.15	−3.20	.001

APPENDIX 3

TABLE A4 Model results of compliance.

	Estimate	SE	Est./SE	*p*-Value
Motivation post-test – Perceived choice ON				
Motivation pre-test – Intrinsic	0.25	0.16	1.58	.115
Motivation pre-test – Identified	−0.20	0.19	−1.06	.291
Motivation pre-test – Extrinsic	0.31	0.12	2.68	.007
Compliance with scaffold – No, easier than scaffold	0.04	0.06	0.71	.480
Compliance with scaffold – Yes. like scaffold	−0.17	0.08	−2.08	.038
Compliance with scaffold – No. harder than scaffold	−0.11	0.11	−1.08	.281
Motivation post-test – Pressure/tension ON				
Motivation pre-test – Intrinsic	0.19	0.14	1.34	.182
Motivation pre-test – Identified	−0.36	0.20	−1.80	.072
Motivation pre-test – Extrinsic	0.16	0.11	1.50	.133
Compliance with scaffold – No, easier than scaffold	0.09	0.07	1.22	.224
Compliance with scaffold – Yes, like scaffold	−0.19	0.08	−2.29	.022
Compliance with scaffold – No, harder than scaffold	−0.04	0.12	−0.37	.715
Motivation post-test – Interest/enjoyment & competence ON				
Motivation pre-test – Intrinsic	−0.11	0.15	−0.72	.471
Motivation pre-test – Identified	0.15	0.25	0.59	.555
Motivation pre-test – Extrinsic	−0.32	0.13	−2.35	.019
Compliance with scaffold – No, easier than scaffold	−0.08	0.07	−1.08	.281
Compliance with scaffold – Yes, like scaffold	0.22	0.08	2.71	.007
Compliance with scaffold – No, harder than scaffold	−0.07	0.12	−0.54	.587
Compliance with scaffold – No, easier than scaffold				
Motivation pre-test – Intrinsic	−0.21	0.12	−1.75	.081
Motivation pre-test – Identified	−0.12	0.17	−0.74	.458
Motivation pre-test – Extrinsic	0.03	0.14	0.21	.835
Compliance with scaffold – Yes, like scaffold				
Motivation pre-test – Intrinsic	0.25	0.12	2.12	.034
Motivation pre-test – Identified	0.07	0.17	0.39	.700
Motivation pre-test – Extrinsic	0.15	0.13	1.08	.281
Compliance with scaffold – No, harder than scaffold				
Motivation pre-test – Intrinsic	0.62	0.20	3.15	.002
Motivation pre-test – Identified	−0.56	0.25	−2.21	.027
Motivation pre-test – Extrinsic	−0.09	0.19	−0.49	.622
Motivation post-test – Pressure/tension WITH				
Motivation post-test – Perceived choice	0.40	0.12	3.30	.001
Motivation post-test – Interest/enjoyment & competence WITH				
Motivation post-test – Perceived choice	−0.48	0.14	−3.39	.001
Motivation post-test – Pressure/tension	−0.48	0.16	−3.07	.002