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Effects of Enhancing Relevant Prior Knowledge on Students' Adoption of Active Learning: A Quasi-Experimental Study(*)

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آثار تعزيز المعرفة السابقة ذات الصلة على تبني الطلاب للتعلم النشط: دراسة شبه تجريبية

نواف عوض خلاف الرشيدي
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الملخص

هدفت هذه الدراسة إلى تقييم أثر تعزيز المعرفة الرياضية السابقة ذات الصلة بموضوع معين على تبني الطلاب للتعلم النشط عند دراستهم لمواضيع جديدة ذات صلة، أُجريت دراسة شبه تجريبية على مجموعتين من طلاب الصف الثالث الابتدائي، إحداهما تجريبية ضمت (47) طالبًا والأخرى ضابطة ضمت (44) طالبًا، كشفت النتائج أن تعزيز المعرفة الرياضية السابقة ذات الصلة بموضوع معين ساهم بشكل كبير في تبني الطلاب للتعلم النشط عند دراستهم لمواضيع جديدة ذات صلة، بالمقارنة مع الطلاب الذين لم يتلقوا تعزيزًا قبل دراسة مواضيع جديدة ذات صلة، أظهر الطلاب الذين تلقوا تعزيزًا انخفاضًا ملحوظًا في الحمل المعرفية وتحسنًا إيجابيًا في تقديرهم للتعلم النشط واستجاباتهم له، وبالتالي، زاد هذا التعزيز من الموارد المعرفية للطلاب وحفزهم على تبني التعلم النشط.

الكلمات المفتاحية: التعلم النشط، الحمل المعرفي، الدافعية، المعرفة السابقة ذات الصلة، التعلم المنظم ذاتيًا.

Effects of Enhancing Relevant Prior Knowledge on Students' Adoption of Active Learning: A Quasi-Experimental Study

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Abstract

The study aimed to assess the effect of enhancing relevant topic-specific prior mathematical knowledge on students' adoption of active learning when they are studying related new topics. A quasi-experimental study was conducted with two groups of primary third-grade students, including an experimental group of 47 students and a control group of (44) students. The results revealed that enhancing relevant topic-specific prior mathematical knowledge significantly contributed to students' adoption of active learning when they were studying related new topics. Compared with students who did not receive enhancement prior to studying related new topics, students who received enhancement showed significant declines in cognitive load and improved positively in valuing active learning and responses to active learning. Hence, the enhancement increased the students' cognitive resources and motivated them to adopt active learning.

Keywords: active learning, cognitive load, motivation, relevant prior knowledge, self-regulated learning.

Introduction:

The aim of active learning is to encourage students to engage effectively with learning. Active learning includes a wide variety of instructional practices, ranging from short activities that the teacher can integrate into a conventional lecture class, such as think-pair-share, brainstorming or one-minute paper activities (simple active learning with interactive lectures) to complex activities, such as problem-based learning, which requires students to become self-regulated learners (Felder, 1992, 1994; Felder & Brent, 2009, Malan, Ndlovu & Engelbrecht, 2014; Mleiki, 2025).

Despite the superiority of active learning over a passive instruction environment (Boedeker, Schlingmann, Kailin, Nair, Foldes, Rowley & Ismail, 2024; Deslauriers & Wieman, 2011; Deslauriers, McCarty, Miller, Callaghan & Kestin, 2019; Silembung, Jainuddin & Siregar, 2024; Hussain, 2024), students are still reluctant to adopt this practice. There are several possible reasons for this unwillingness, including students' dislike of responsibility, dislike of working in groups and lack of clear instruction (Belcher, 2003; Felder, 2007, 2010; Felder & Brent, 1996; Vuorela & Nummenmaa, 2004). Research has indicated that students with high prior knowledge generally prefer a more active learning method, while students with lower prior knowledge tend to follow instruction passively (Bernacki, Byrnes & Cromley, 2012; Zhao, Yang, Lian & Wu, 2024).

Prior knowledge is one's existing knowledge comprising content, skills and beliefs (Hattie & Yates, 2013). No previous study has assessed the effect of the manipulation of prior knowledge on students' active learning adoption.

The present study began with a review of obstacles to active learning adoption, followed by a discussion of effective active learning and its requirement for self-regulative learning (SRL). The relationship between SRL and prior knowledge within cognitive load is also discussed. Limiting the scope to the content of relevant topic-specific mathematical knowledge, which makes up the foundation for subsequent learning, the experiment documented here attempts to answer the following main research question:

What is the effect of enhancing relevant topic-specific prior mathematical knowledge on students' adoption of active learning when they are studying related new topics?

Obstacles to Active Learning Adoption:

Intensive research has shown that students learn significantly better in active learning environments than they do when exposed to passive instruction (Boedeker et al., 2024; Deslauriers et al., 2019; Silembung et al., 2024; Deslauriers & Wieman, 2011; Al-Moghyrah, 2024). Despite this empirical evidence, most classes are unable to switch to active learning approaches (Deslauriers et al., 2019; Henderson & Dancy, 2007; Al-Ali). The literature reveals several obstacles that prevent the adoption of active teaching strategies, such as limited resources, insufficient time, a lack of school support, teachers 'concerns about evaluations of their teaching, concerns about content coverage and underestimates it (du Plessis, 2020; Henderson, Stelzer, Hsu & Meredith, 2005; Ramnarain & Hlatswayo, 2018). Most importantly, students resist active learning approaches and prefer traditional methods (Belcher, 2003; Dancy & Henderson, 2007; Felder, 2010; Henderson & Dancy, 2007; Henderson, Dancy & Niewiadomska-Bugaj, 2012). There are several reasons for this resistance, such as a dislike of taking on more responsibility for their own learning (Felder, 2007, 2010), resentment at being forced to interact with other students (Felder & Brent, 1996; Vuorela & Nummenmaa, 2004) and a lack of clarity of instruction (Belcher, 2003).

Obstacles to the adoption of active learning are also related to students' prior knowledge. Research indicates that students with high prior knowledge generally use a more active learning method, whereas students with lower prior knowledge passively follow instruction (Bernacki et al., 2012; Greene, Moos, Azevedo & Winters, 2008). This is because students with high prior knowledge are able to demonstrate more SRL compared with students with lower prior knowledge. This is discussed in later section (SRL and Prior Knowledge within the Cognitive Load).

Effective Active Learning Requires SRL:

When learners engage in active learning, they need to demonstrate *self-regulation*, which "refers to self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman, 2000:14). Engaging in active learning requires students to regulate their behaviours (Virtanen, 2017). Self-regulated learning and active learning involve several common elements. In both learning conditions, the teacher should facilitate and encourage learners, while students should be active, critical, and reflective. The obvious difference between active learning and SRL is that SRL involves processes guided by the learners, whereas active learning involves teaching and learning methods planned by a teacher (Virtanen, 2017). This means that involving learners in active learning inevitably requires the use of SRL processes, such as analysing a task, planning a strategy, implementing the strategy, and evaluating goal achievement. For example, when students need to solve a mathematical problem, they have to analyse the problem, identify the proper strategy to solve the problem, implement that strategy and evaluate the solution. To complete these activities, students need to be aware of their learning status so that they can change their learning strategies or deal with their weaknesses. This process corresponds to the core function of SRL. All these processes are carried out within one’s limited working memory capacity. Working memory is responsible for constructing a mental schema in long-term memory (i.e. learning) (Sweller, Van Merrienboer & Paas, 1998). The resources of working memory that are devoted to learning a specific task need to be sufficient; otherwise, as discussed in the next section, the working memory will be overloaded.

SRL and Prior Knowledge within the Cognitive Load:

Studies have shown that students with higher levels of prior knowledge are more able to control their learning (i.e. conducting self-regulated learning) than students with less prior knowledge (Alreshidi, 2021; Mihalca & Mengelkamp, 2020; Song, Kalet & Plass, 2016). Sufficient and accurate prior knowledge for subsequent learning increases cognitive resources, allowing students to conduct SRL. This occurs for at least two reasons: First, students have sufficient pre-existing knowledge to assess their needs and make decisions for subsequent learning. Students with higher levels of prior knowledge have a greater ability to identify their knowledge needs and make their information selections accordingly (Gall & Hannafin, 1994; Lawless & Kulikowich, 1996; MacGregor, 1999). Second, interacting elements of subsequent learning can be lower when students have sufficient prior knowledge, paving the way for SRL to be activated. Students with more prior knowledge can incorporate the relevant prior knowledge into schemas that can be addressed as a single element, leading to reduced interacting elements during learning; consequently, the working memory load can be reduced (Sweller, Ayres & Kalyuga, 2011). The room of working memory resources left for conducting SRL, which requires cognitive effort (Seufert, 2018).

Working memory is limited in terms of duration and the quantities of information that can be processed; therefore, if a given task exceeds working memory capacity, instruction will be ineffective (Sweller et al., 2011). However, as mentioned above, the availability of relevant prior knowledge increases a learner's working memory capacity by reducing element interactivity (Feldon, 2007; Sweller et al., 2011). When students have sufficient and accurate relevant prior knowledge for subsequent learning, and they engage in active learning, the teacher focuses on facilitating their SRL. In contrast, teachers of students who have poor relevant prior knowledge focus more on improving students' relevant prior knowledge rather than the learning processes for new knowledge (Alreshidi, 2021). Therefore, students with less prior knowledge need additional support to address this deficiency. As a result, students with lower prior knowledge learn less from active learning activities than students with more prior knowledge do (Kirschner, Sweller, Clark, Kirschner & Clark, 2006).

Highly interacting elements make learning difficult. A difficult task will not allow for effective self-regulated learning processes to address the task. As a task becomes more difficult because of a lack of relevant prior knowledge, the cognitive load begins to increase, whereas SRL begins to decline (Seufert, 2018). Difficulty diminishes not only the working memory's capacity to invoke the two components of SRL (i.e. cognition and metacognition) but also the other component of SRL, which is motivation. Motivation refers to our willingness to engage and apply our cognitive and metacognitive skills to learning (Seufert, 2018). On the one hand, positive motivation is associated with a decreased perception of task difficulty (Clark, 1999; Plass, Heidig, Hayward, Homer & Um, 2014; Um, Plass, Hayward & Homer, 2012). On the other, when a given task exceeds a learner's working memory capacity, this does not motivate the learner to invest mental effort (Kimchi, 1982; Yeh & Wickens, 1988). Tobias (1994) reported that about 20% of the variance related to students' motivation in a learning process is explained by prior knowledge. Therefore, highly relevant prior knowledge not only increases working memory capacity but also improves motivation for learners; consequently, it also supports students in using more sophisticated learning strategies, such as active learning (Schiefele, 1991).

Statement of the study:

Learning environments can be designed to strengthen students' relevant prior knowledge, thereby enhancing the cognitive resources needed to engage in active learning. When learners possess sufficient and accurate prior knowledge, they are better able to regulate their learning effectively and allocate their cognitive efforts more efficiently. Prior knowledge stored in long-term memory also supports and expands the capacity of working memory, which helps reduce cognitive load during learning tasks. This reduction in cognitive load might increase students' motivation to engage in self-regulated learning and encourages the use of more advanced learning strategies, including active learning approaches. Accordingly, this study may offer valuable insights to help teachers facilitate the adoption of active learning in their classrooms.

Questions of the study:

1- What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on cognitive load when students study new topics in an active learning context?
2- What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on the way students value active learning when the students study new topics in an active learning context?
3- What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on making students respond positively to active learning when the students study new topics in an active learning context?

Questions of the study:

1- To examine the effect of enhancing relevant topic-specific prior mathematical knowledge before introducing new topics on students' cognitive load in an active learning context.

2- To investigate the effect of enhancing relevant topic-specific prior mathematical knowledge on how students value active learning when studying new topics within an active learning environment.
3- To determine the effect of enhancing relevant topic-specific prior mathematical knowledge on students' positive responsiveness to active learning when engaging with new topics in an active learning context.

Methodology:

Participants and Design of study:

A school in an urban district of the major city of Ha'il, Saudi Arabia, was chosen for the study. The teachers and school administration were willing to participate in the study. The sample consisted of 91 male third-grade Saudi primary school students (age: M = 8.8 years; SD = 0.22). This study was restricted to male students because of the gender segregation system operating in Saudi Arabia. Four classes of students were divided into two groups. Two classes (n = 47) were randomly selected as the "experimental group", and the other two classes (n = 44) were selected as the "control group" (see Table 1). A quasi-experimental design was applied. The same mathematics teacher taught the groups. All participants and children parents gave their consent and agreed to participate in this study. The participants have been informed that they could withdraw at any time of the study without providing a reason. G*Power 3.1 was used to conduct a post hoc power analysis to check the adequacy of the sample size, and it returned a power level of 0.97 (see, Faul, Erdfelder, Lang & Buchner, 2007). That is, the sample size was adequate for the study.

Table (1)
Division of Participants for the Study

Number of classes	**4 classes (2 classes in the experimental group and 2 classes in the control group).**
Number of students	**91 male students.**
Number of groups	**2 groups (47 students in the experimental group and 44 students in the control group).**

A positivist research philosophy was adopted in this study. Positivism underlines the assumption that the world is controlled by the laws of the universe, and discovering these laws allows investigators to understand social phenomena (Creswell, 2003). The scientific theories can be tested by statistical and controlled variables using surveys or experiments (Hammersley and Atkinson, 2007).

This study employed deductive approach. Deductive research is characterized by starting with a theory or hypothesis and then testing it through the collection and analysis of data (Leavy, 2017). The study adopted a quantitative cross-sectional quasi-experimental design as discussed above.

Materials:

Topics:

The study unit selected based on the teacher's plan of topics. The Unit was "Represent and interpret data." The unit included the five following topics: represent and interpret pictographs (two topics, taught in four lessons), represent and interpret bar graphs (two topics, taught in four lessons) and probability (one topic, taught in two lessons). All content topics were new to the students. The instruction experiments lasted for three weeks and were conducted in ten 45-minute sessions (four sessions per week, each session lasting 45 minutes). The time allocated for both groups was the same.

Strategy Implementation

As a team, the author and the teacher identified the content of the relevant topic-specific mathematical prior knowledge for each topic intended to be taught. The content design of the prior knowledge was carried out in the three following phases: (1) the team identified the unit of 'represent and interpret data' with five topics requiring (10) sessions, (2) the relevant topic-specific mathematical prior knowledge for each topic intended to be taught was identified and (3) small problems were developed to address the identified prior knowledge.

In the intervention, the control group was presented with problems involving topics where deliberate practices would be used. Students in the experimental group were, first, presented with problems that aimed to enhance relevant topic-specific mathematical prior knowledge. They received feedback, and they were then presented with topic problems using deliberate practices (explained below). For example, the topic of counting and addition is relevant prior knowledge for the topic of representing a pictograph. The teacher began by dividing the students into subgroups and presenting them with the following problem: "We are planning to take a trip, but we are not sure of the class's preferences in terms of ice cream flavours, kinds of juice, place, and day to go. Could you find out?" Each class was divided into smaller groups and assigned tasks. Group (1) had to ask all students one by one which ice cream flavour they liked, group (2) had to find out what kinds of juice they liked and so on. They presented their work at the end of the assignment and received feedback from the teacher.

The validity of prior knowledge content was verified by three experts in the field in terms of appropriateness, relevance, and sufficiency for the purpose of the study. Both groups were taught using active learning approaches. The only difference between the groups was that the students in the experimental group received an enhancement for relevant topic-specific mathematical knowledge at the beginning of each topic (five topics).

The new topics were taught based on the principles of deliberate practice (see Ericsson, Krampe & Tesch-Römer,1993), in which the students worked together in small groups and were instructed to solve the sample problems while the teacher went from group to group in the classroom, offering help and asking questions. Once the students had attempted each problem, the teacher provided a full solution. The strategy of enhancing relevant topic-specific prior knowledge consisted of activating, reinforcing, and remediating relevant prior knowledge. The enhancement could not take more than (20) of the (45) minutes for each topic. All students in both groups were actively engaged throughout the research period of (10) school days, making the groups fully student-centred (Stains et al., 2018), See figure (1).

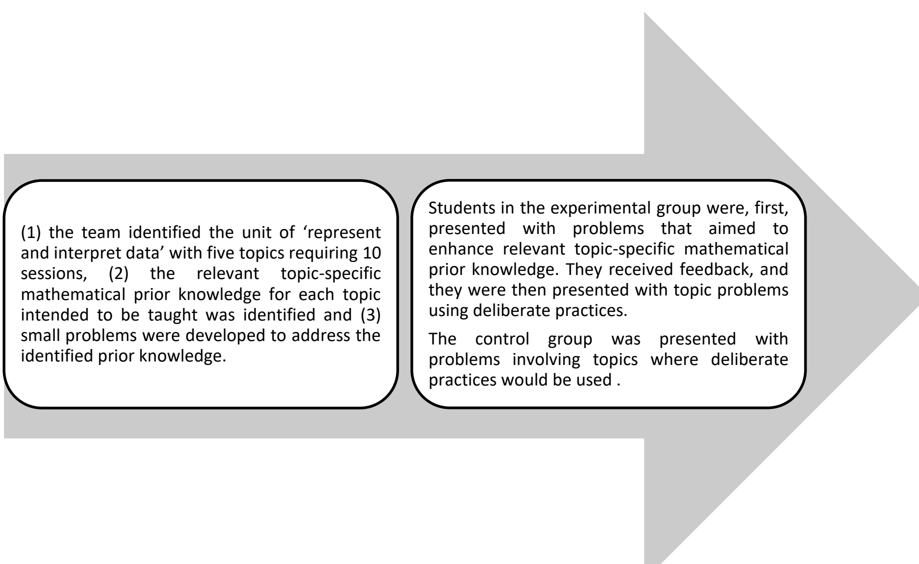

Figure (1) Strategy Implementation

Instruction:

Before the intervention, all students in both groups were taught using mostly traditional methods (teacher report). However, during the intervention, the students were taught using active learning approaches. To confirm this prior to the intervention, all students in both groups were asked to rate their level of agreement with the following statement: "This class mostly involved me acting as a listener while the instructor presented information" (adopted from Deslauriers et al., 2019:3) on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The same statement was repeated after the intervention. This was necessary to ensure that the students experienced more active learning during the intervention than they did before it.

Methods of Assessing Active Learning Adoption:

The following indications can show how the teaching strategy affected students in terms of adopting active learning: a) cognitive load measurement, b) students' value of instruction and c) students' positivity towards the instruction. The factors were assessed via questionnaires.

Cognitive load measurement:

The students were asked to rate their perceived difficulty for each problem (five problems that followed five new topics immediately, or a problem for each new topic) on a 5-point Likert scale, ranging from "very easy" to "very difficult", after the students had a chance to attempt to solve the problems, but before they were fully explained (see Table 2; Sweller, 2011). The subjective rating scale is valid, reliable and easy to use (e.g. Szulewski et al., 2018). The response to the question was initially plotted on a 9-point Likert scale; however, three experts who reviewed the measurement suggested changing it to a 5-point Likert scale because of the students' age.

Student responses to instruction:

The Student Responses to Instruction questionnaire consists of two scales-namely, value and positivity-each of which consisted of three items. The scales were adopted from Nguyen, Husman, Borrego, Shekhar, Prince and Demonbrun (2017). They were verified by three experts in teaching mathematics. The questionnaire was verified; the reliability of the test-retest was 0.89, and the internal consistency for the sub-scale of the tests was 0.92. The questionnaire's scales are as follows:

Value:

- "I felt that the time used for the activity was beneficial.
- I saw value in the activity.
- I felt that the effort it took to do the activity was worthwhile".

Positivity:

- "I felt positive towards the instructor/class.
- I felt that the instructor had my best interests in mind.
- I enjoyed the activity".

The students responded on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree).

Procedures:

The four classes were randomly allocated into two groups-namely, the "experimental group" and the "control group." The study has been reviewed and approved by the research ethics committee. All participants and their parents agreed to take part in the study and provided their written consent. Figure (2) shows that both groups received pre-measurements for "placing value on instruction" and "positivity of instruction." The experimental group received enhancement, while the control group did not. Both groups were then taught using active learning approaches. During the intervention, the cognitive load was applied. After the intervention was completed, both groups received post-measurements for "placing value on instruction" and "positivity of instruction." The collected data were analysed using IBM SPSS v (22). The data were analysed using the *t*-test and one-way analysis of covariance (ANCOVA). The main assumptions included normality; moreover, the homogeneity conditions were checked, and the assumptions were met.

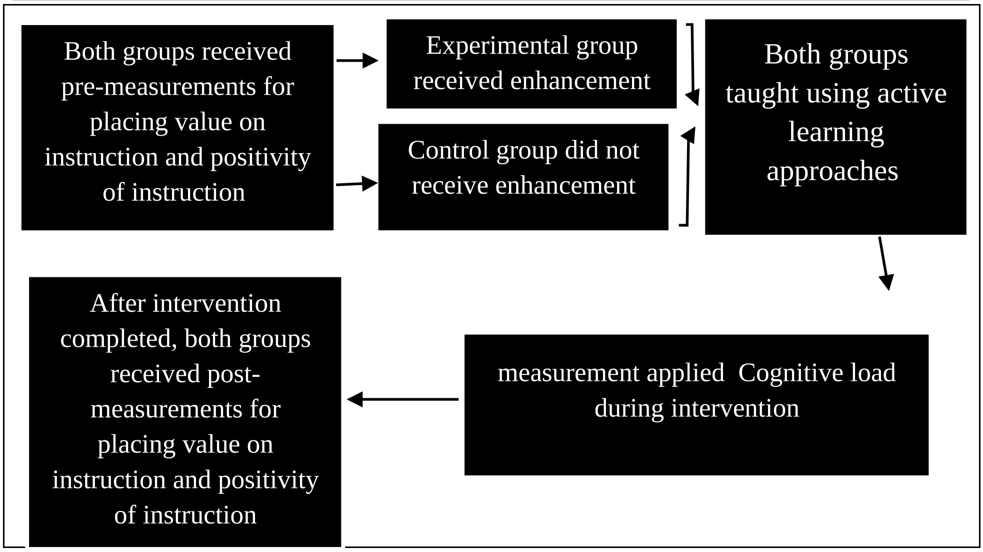

Figure (2) Study Design

Results:

Three indications were evaluated to determine how enhancing relevant prior topic-specific mathematical knowledge before introducing new topics affects students in adopting to active learning. These indications were as follows: a) cognitive load measurement, b) students' placing value on active learning and c) students' positivity towards active learning. Before presenting these results, I had to make sure that the students had experienced more active learning during the intervention compared with before.

All students in both groups were taught using traditional methods prior to the intervention (teacher report). However, during the intervention, students were taught using active learning approaches. To confirm this prior to the intervention, all students in both groups were asked to rate their level of agreement with the following statement: 'This class mostly involved me acting as a listener while the instructor presented information'. The same statement was repeated later, post-intervention. As expected, students agreed with this statement more strongly before the intervention ($M = 4.1$) than they did after the intervention (3.2, $p < 0.001$). This confirmed that students were taught using more active learning during the intervention than in the period just before. In the following subsections, I present the results by research question:

- **What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on cognitive load when students study new topics in an active learning context?**

Cognitive load measurement was applied for only the five new topics-specifically, the first problems immediately following the enhancement (i.e. five problems in total). Table 2 shows that there was a significant difference in the post-test, *t* (89) = (4769, p < 0.01). This indicates that students in the experimental group had significantly lower average scores in cognitive load measurement (M = 19.79, SD = 3.17) than students in the control group (*M* = 22.30, SD = 1.66), with a large effect size (0.85).

This result indicates that enhancing relevant prior mathematical knowledge before teaching a new topic significantly lowered students' cognitive load for learning the new topics when compared with not receiving the enhancement. This also indicates that students who did not receive the enhancement prior to learning the new topic suffered more from a high cognitive load than did students who received the enhancement (*M* = 22.3 out of 25).

Table (2)

Summary of t-Test Results of Cognitive Load Measurement

Variable	Group	N	M	SD	t	η^2
Post-test	Exp.	47	19.79	3.17	-4769*	0.85
	Con.	44	22.30	1.66		

Note. *p < 0.05 and *p < 0.01.

- **What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on the way students value active learning when the students study new topics in an active learning context**?

The *t*-test results shown that there was no significant difference in the pre-test scores for the control and experimental groups in terms of placing value on active learning (*t* = 1.86). Table 3 shows that there was a significant difference in the post-test, F (1, 89) = (6.83, p < 0.05). This indicates that students in the experimental group had significantly higher average scores in placing value on active learning (M = 11.13, SD = .108) than did students in the control group (M = 10.30, SD = 1.89), with a small effect size (0.073).

This result shows that enhancing relevant mathematical prior knowledge before teaching a new topic induced students to place a significantly higher value on active learning for learning the new topics when compared with students who did not receive the enhancement.

Table (3)

Summary of ANCOVA Results of Placing Value on Active Learning

Variable	Group	N	M	SD	Adjusted mean	F	η^2
Post-test	**Exp.**	**47**	**11.13**	**1.08**	**11.12**	**6.83***	**0.073**
	Con.	**44**	**10.30**	**1.89**	**10.30**		

Note. *p < 0.05 and **p < 0.01.

- **What is the effect of enhancing relevant topic-specific prior mathematical knowledge before addressing new topics on making students respond positively to active learning when the students study new topics in an active learning context?**

The t-test results shown that there was no significant difference in the pre-test scores of the control and experimental groups in terms of students' positivity towards active learning (t = .094). Table 4 shows that there was a significant difference in the post-test, F (1, 89) = (4.81, p < 0.05). This indicates that students in the experimental group had significantly higher average scores in positivity towards active learning (M = 11.98, SD = 5.37) compared with students in the control group (M = 10.10, SD = 1.97), with a small effect size (0.052). This result shows that enhancing relevant mathematical prior knowledge before teaching a new topic improves students' positivity towards active learning to a greater degree compared with no enhancement.

Table (4)

Summary of ANCOVA Results of Positivity Towards Active Learning

Variable	Group	N	M	SD	Adjusted mean	F	η^2
Post-test	**Exp.**	**47**	**11.98**	**5.37**	**11.98**	**4.81***	**0.052**
	Con.	**44**	**10.10**	**1.97**	**10.10**		

Note. *p < 0.05 and **p < 0.01.

Discussion:

The main aim of the present research was to determine the effect of enhancing relevant prior topic-specific mathematical knowledge on subsequent learning in terms of students' active learning adoption. The results revealed that enhancing prior knowledge supported students' active learning adoption by lowering their cognitive load and making students respond more positively to instruction in terms of active learning when compared with not receiving enhancement.

From a cognitive load perspective, the capacity of working memory can be limited when dealing with knowledge in which relevant prior knowledge is lacking. Relevant prior knowledge stored in long-term memory supports working memory capacity (Ericsson & Kintsch, 1995; Sweller, 2003). When students' relevant prior knowledge is more sufficient and accurate, working memory should deal with subsequent new learning with a greater capacity, and vice versa.

Students with more prior knowledge can incorporate relevant prior knowledge into schemas that can be addressed as a single element, leading to fewer elements interacting during learning; consequently, the working memory load can be reduced (Sweller et al., 2011). Instead, students concentrate on combining relevant prior knowledge with new information. Students with higher prior knowledge can assess their needs and make decisions for subsequent learning. Moreover, such students have a greater ability to identify their knowledge needs and make their information selections accordingly (Gall & Hannafin, 1994; Lawless & Kulikowich, 1996; MacGregor, 1999). Therefore, when students' relevant prior knowledge is enhanced, interacting elements of learning are reduced and SRL increases, and vice versa. As a task becomes more difficult because a lack of relevant prior knowledge, cognitive load begins increasing and SRL begins to decline (Seufert, 2018). The availability of working memory resources, as a result of enhancing relevant prior knowledge, is likely to be used for conducting SRL and is key for effective active learning. SRL demands cognitive effort (Seufert, 2018).

Engaging in active learning requires students to regulate their behaviours (Malan et al., 2014; Virtanen, 2017), and students with higher prior knowledge control their learning better than students with lower prior knowledge do (Alreshidi, 2021; Bernacki et al., 2012; Mihalca & Mengelkamp, 2020; Song et al., 2016). This could explain why students with higher levels of prior knowledge require less instructional support compared with students with lower prior knowledge (Chen, Fan & Macredie, 2006).

In the results, students’ responses to active learning differed according to whether they received enhancement. This showed that responses to active learning (including placing value on active learning and responding positively towards active learning) for students who received the enhancement were significantly more positive compared with those of students who did not receive the enhancement. Students with higher prior knowledge demonstrated more positive attitudes towards active learning than students with less prior knowledge did (Usman & Miranda, 2020; Winters, Greene & Costich, 2008; Yüksel, 2014). This is because reducing the cognitive load increases students’ motivation to learn. In contrast to students who experienced a lower cognitive load, students who experienced a high cognitive load felt overwhelmed and consequently their attitudes towards learning declined (Mullins & Sabherwal, 2020; Wu, 2018). Students who have more positive attitudes show a higher engagement in learning and invest more effort in it (Lawless & Kulikowich, 1996), which encourages students to use more sophisticated learning strategies, such as active learning (e.g. Schiefele, 1991). Therefore, enhancing relevant prior knowledge increases working memory capacity and motivates students to adopt active learning, probably because this paves the way for SRL to function. This result may raise awareness of importance of prior knowledge to adopt active learning.

Conclusion:

When students received enhancement in relevant prior topic-specific mathematical knowledge, they adopted more active learning on the subsequent learning. This is because enhancement for their relevant prior knowledge is reduced cognitive load, improved response to active learning, and place value on active learning compared with a situation in which students do not receive enhancement. Learning new topics is not independent of students’ prior knowledge; indeed, it depends on such knowledge. When students come to new learning with greater relevant prior knowledge, the subsequent learning becomes more controllable for students because of increasing cognitive resources. As students are able to control their learning, they engage more in an active learning context compared with students who are less able to manage their learning. Despite the study strengths, this study had some limitations. This study was restricted to male students because of the gender segregation system operating in Saudi Arabia. The results of this study could be generated in any situation that requires learning new knowledge that can potentially increase cognitive load. The sample was not randomly chosen, however the classes only in the school was randomly chosen. In addition, more research is needed to investigate the effects of this strategy on older students and compare its effect on different levels of students' abilities (high and low achievers).

Recommendations:

Based on the findings of this study, it is recommended that teachers and curriculum designers intentionally incorporate structured enhancement of relevant topic-specific prior mathematical knowledge before introducing new topics, as this practice effectively reduces students' cognitive load and encourages stronger adoption of active learning. Teachers are encouraged to integrate brief warm-up activities, micro-lessons, and formative assessments to identify and reinforce essential prerequisite knowledge, ensuring students enter new lessons with sufficient cognitive resources. Instructional materials should be designed to minimize unnecessary cognitive demands through clear visuals, sequenced scaffolding, and explicit connections between prior and new concepts. Curricula should embed mini-review sections, diagnostic checkpoints, and reflective prompts that help students recognize how their existing knowledge supports active engagement in learning. Additionally, fostering a classroom culture that values active learning-and providing professional development for teachers in strategies that strengthen prior knowledge-will further support students' confidence, motivation, and positive responses toward active learning across mathematical topics.

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