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The Employment of Active Learning Strategies by Mathematics Teachers and the Obstacles to their Use

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Abstract

The present study aimed at investigating the degree of mathematics teachers' use of active learning strategies (ALSs) in their teaching practices, and to identify the obstacles hindering their use of this strategy. A questionnaire was distributed to 241 mathematics teachers (of whom 27 were interviewed) working in public secondary schools in the city of Amman in Jordan. A descriptive approach was used to determine the extent to which the participant teachers use LESs in their teaching practices. The findings revealed that the participants used ALSs to a moderate degree. Moreover, there were no statistically significant differences in terms of gender, academic qualifications, and teaching experience. However, the participants reported impediments to the use of ALSs related to teacher, student, subject, curriculum, and school environment.

Keywords: *active learning, mathematics, obstacles, mathematics learning, teaching methods*

1. Introduction

Advancements in knowledge and technology have led to calls for pedagogical reforms, especially regarding the role of the learner. Modern learning theories stress the need for shifting student's position from that of recipient to the producer of knowledge and to inspire them to acquire long-term knowledge driven by self-motivation. Students should engage in all aspects of their learning and develop the capacity for self-learning by exploring and investigating rather than relying on the teacher to produce information (Willson & Preper, 2004). The concept of *active learning* and the interest in its application emerged at the close of the 20th century, when science, cognition, and technology made rapid advances. These advances continually push education to be more about ways of thinking including creative approaches to problem-solving and decision-making. This, however, requires learners to influence what they want to learn and how they learn it. In active learning, students' learning process is transformed from firmly predetermined to open-ended, which allows them to actively participate in shaping their learning experiences. Therefore, active learning is called sometimes teacher-facilitated teaching approach or student driven learning approach (Davidson, 2016).

The value of incorporating active learning can be seen in its positive effects on the teacher-student relationship, classroom atmosphere, and students' motivation. Studies have shown that active learning leads to intellectual curiosity, teamwork, creativity, problem-solving, and thinking skills rather than memorization and indoctrination, which all benefit students' present and long-term progress (Budair, 2008; Hassan, & Al-Kinani, 2022). Since students commonly report feeling uncertain about their learning, many studies have emphasized active learning as a way to address this problem by making it possible for students to properly integrate new pieces of knowledge into their knowledge systems (actual learning) after each teaching activity and boosting their learning motivation (Haney, 2003; Stewart et al., 2004).

Many studies have shown that traditional lecture method, which is commonly used in the Jordanian schools, does not promote actual learning, nor does it engage students in active learning (Al-Maliki et al., 2011). This spotlights the need to follow the ALSs to teach all subjects in Jordanian schools, especially mathematics. Al-Jaafrah (2015) affirmed the need for repositioning teachers and students in order to implement active learning effectively. However, traditional methods based on indoctrination are still the most commonly used strategies in Jordanian schools. In light of this, the present study aimed to determine the state-of-the-art regarding ALSs in mathematics secondary public schools in Jordan and identify the obstacles that hinder the implementation of this approach. The research questions were as follows:

Q1. To what degree do secondary public school mathematics teachers in the city of Amman use ALSs?

Q2. Does the degree of use of ALSs by secondary public school mathematics teachers in the city of Amman differ according to the variables gender, academic qualification, and teaching experience?

RQ3. What obstacles prevent secondary public school mathematics teachers in the city of Amman from using ALSs?

2. Literature Review

2.1 Active Learning

Active learning is an instructional method used to give students opportunities to engage actively in their own learning through thinking, doing, and/or discussing the relevant content (Prince, 2004). Active learning is based on the constructivist learning theory, which stresses that learners actively create their own knowledge rather than passively receive it from the teacher or the textbook (Liu & Chen, 2010). Active learning requires both teachers and students to play roles different from those they used to play in traditional education. Teachers' role in active learning changes from being a lecturer to being the facilitator of students' learning by creating an environment that is conducive to learning (Broad, Matthews, & McDonald, 2004; Ishii, 2017). Activating active learning requires students to be active producers of knowledge, not passive receptors of it (Aşiroğlu, 2014; Eugéne, 2006).

Paying attention to the role of the student and placing them at the centre of the learning process is the essence of active learning. This stresses the importance of enabling each student to learn and reach a level of mastery commensurate with their pace, abilities, and intelligence. Each individual student should have their own style, method, and learning strategy (Al-Saadi, 2011). Many active learning strategies have been developed to accommodate differences between learners. The variety of goals and subject materials means that teaching methods have to be more diverse. According to Ahmed (2018), employing a single strategy for every educational setting is no longer effective. However, the student must be at the centre of the teaching/learning process, regardless of how the strategies differ.

2.2 Common Forms of Active Learning

Active learning encompasses a wide range of contemporary teaching strategies, the most effective being cooperative learning, problem-based learning, discovery-based learning, project-based learning, and brainstorming. For Al-Banna and Adam (2008), this multiple approach is the best way to teach mathematics.

Cooperative learning is a structured form of group work that allows students to individually achieve a common goal. Cooperative learning relies on the interaction and collaboration between students. Classes are divided into small groups of different levels of students' performance. The groups then complete assigned tasks collaboratively (Khairy & Ayman, 2018). This strategy places the student at the centre of the educational process and allows them to collaborate with their peers. It fosters individual and group responsibilities, boosts self-esteem, teaches students to accept other people's viewpoints, and accounts for individual variance (Qarni, 2013). The leader of each group manages the group and its resources and records, authors, and reports the findings (Al-Abd et al., 2012). Meanwhile, the responsibility of the teacher is limited to selecting the topic, running the class, locating resources, deciding on activities, mentoring the students, and assessing their performance (Hussein, 2005).

Problem-Based Learning refers to the learning environment in which problems drive the learning. In this environment, students use of their research and investigation skills to develop several solutions to a problem set by the teacher, drawing on their previous knowledge and experience. The best solution is then chosen (Mehriya, 2017). The specific steps followed by the student to solve the problem are as follows: understanding the situation, gathering information on it, proposing solutions to the problem (via hypotheses), discussing the proposed solutions, arriving at the best solution (the conclusion), then presenting the answers obtained (Dabash & Hadid, 2022). Problem-based learning affords students opportunities to think critically, show their own creative ideas, and communicate with peers mathematically (Hiebert et al., 1997).

Discovery-Based Learning refers to a process whereby the student is confronted with a situation that makes them feel confused and prompts them to ask many questions, inspiring them to look into the problem, and come up with answers (Tibawi & Doumi, 2019). Therefore, learning becomes more meaningful for students and what is learned can be stored longer in their knowledge systems. This model is suitable for introducing new mathematical skills and concepts to students. It involves the learner processing, synthesising, and transforming information until they can form a hypothesis or discover something using induction, deduction, or any other mathematical method (Dabash & Hadid, 2022).

Project-based learning is an alternative to memorisation and indoctrination in teacher-led classrooms. Projects are challenging tasks based on a dilemma or issue that tests the student's reasoning and require higher-order thinking skills related to decision-making, investigation, and problem-solving, through which the teacher explains basic concepts and facts (Mataria, 2009). Notwithstanding the debates regarding project-based learning, most educators concur that it is "a planned task and purposeful activity followed by practical experience, undertaken in a social setting" (Kilpatrick, 2001 as cited in Dandash, 2003, p. 62). Project-based learning has also been described as "any field activity carried out by the student and carried out in the application and under the supervision and guidance of the teacher, as long as it is purposeful and serves the scientific material" (Dabash & Hadid, 2022).

Brainstorming is a discussion technique that enables students to develop different ideas when working as part of a group of five to 12 under the teacher's guidance (Sultani, 2010). The teacher must first decide how to situate and clearly state the task, then determine the issue that will be the focus of the brainstorming, define the overall objective and the activity's specific goals, and identify the relevant components and any related challenges (Bakri, 2015).

2.3 Effectiveness of Active Learning

Several studies have pointed to the effectiveness of ALSs, and some have identified barriers to their use. (Hyun, et al., 2017) examined the effect of active learning pedagogies on students' satisfaction of learning processes in ALSs and Traditional Classrooms [TCs]. The results revealed that active learning activities are significant factors that increase students' satisfaction with their individual and group learning processes in both TCs and ALSs. Sibona and Pourreza (2018) investigated the difference between active learning and lecturing in teaching scrum project management in a university environment in the United States over two semesters. A total of 155 students responded to an online survey. The findings showed that the students believed they learnt more through active learning than during lectures, preferring active learning because it engaged them more. Khan et al., (2017) examined the impact of active learning on physics students' achievement. Eighty ninth-grade students in Pakistan were split into an experimental and a control group. The former performed significantly better across all learning stages (information, comprehension, application, problem-solving, observation, and reasoning). They also performed better academically overall. Demirci (2017) conducted a study to determine whether there was a difference in attitudes towards science when ALSs were employed compared with traditional methods. The study involved a random sample of seventh-grade students at Melhat Onugur Secondary School in Eskisehir. They were divided into an experimental and a control group, and there has been a significant difference between these two groups in favour of experimental group at the end of the study.

3. Methods and Procedures

3.1 Data Collection and Sample

The study population consisted of secondary school teachers in public schools in the city of Amman for the academic year 2022/2023 (n = 1438; 677 male and 761 female). A total of 241 secondary school mathematics teachers participated in the study. They were chosen by a simple random method (25%). For the demographic background information, participants were asked to report their gender, academic qualification, and experience. Table 1 shows the distribution of the sample according to the demographic background.

Table 1: Demographic Background of Respondents

Variable	Category	Frequency	%age
Gender	Male	103	42.7
	Female	138	57.3
Academic Qualification	Bachelor's	154	63.9
	Postgraduate	87	36.1
Experience	< 5 years	37	15.4
	5–10 years	62	25.7
	> 10 years	142	58.9
Total		241	100.0

3.2 Instrument

After reviewing the theoretical literature and previous studies (Dabash et al., 2022; Saadeh & Al-

Rashidi, 2017), the authors designed a questionnaire comprising 43 items spread across five areas representing various active learning techniques and a 5-point Likert scale (5 = *always*, 4 = *often*, 3 = *sometimes*, 2 = *rarely*, and 1= *never*). A link was posted on the ministry of education site at the beginning of the first semester of 2022-2023 and kept there until the required number of responses was received. To determine the minimum and the maximum length of the scale, the range (5 – 1 = 4) was divided by five as the highest value (4 ÷ 3 = 1.33). Number 1, the lowest value was added to identify the maximum of this cell. The length of the cells was determined as follows: low degree (1- < 2.33), medium (2.3–3.67), and high (3.68–5).

3.3 Content Validity (Face Validity)

The content validity of the tool (the questionnaire) was checked by presenting it to 11 experts in the field. They were asked to express their opinion of the linguistic integrity of the drafting of the statements and their suitability for the study. The required modifications were then made (i.e., deleting, adding, and reformulating). The tool was accepted by 80% of the experts, and the final version of the questionnaire comprised 38 statements.

3.4 Construct Validity (Internal Consistency)

The construct validity of the tool was checked by extracting the correlation coefficients of each item with the total score of the strategy to which it belonged for a pilot sample (n = 30) of mathematics teachers in secondary-level public schools in the city of Amman. The correlation coefficients ranged between 0.87 and 0.41 (Table 2).

Table 2: Results of the Correlation Coefficients (Survey)

Items	Correlation coefficients	Items	Correlation coefficients	Items	Correlation coefficients
1	.41*	14	.76**	27	.54**
2	.64**	15	.63**	28	.54**
3	.82**	16	.84**	29	.58**
4	.87**	17	.87**	30	.66**
5	.79**	18	.87**	31	.68**
6	.82**	19	.73**	32	.76**
7	.80**	20	.76**	33	.86**
8	.85**	21	.87**	34	.79**
9	.73**	22	.80**	35	.80**
10	.66**	23	.57**	36	.80**
11	.74**	24	.71**	37	.85**
12	.66**	25	.75**	38	.86**
13	.63**	26	.75**		

Note. **Statistical significance was set at 0.01. All correlation coefficients were statistically significant, so none of the items were omitted.

3.5 Reliability

The tool's reliability was verified using the test-retest method on the pilot sample. The Pearson correlation coefficient was calculated between both tests. Cronbach's alpha was used to calculate internal consistency (Table 3). The values were acceptable.

Table 3: Cronbach's Alpha/Test-Retest Reliability

Field	Test-retest	Internal consistency
Cooperative learning	0.84	0.82
Problem-based learning	0.80	0.71
Discovery-based learning	0.82	0.77
Project-based learning	0.85	0.80
Brainstorming	0.88	0.83

3.6 The Interviews

The interviews were based on Ghanem et al.'s (2020) methodology. The participants (n = 27) were asked individually to answer one open ended question (after it being validated by experienced mathematics teachers and supervisors): "What are the obstacles preventing mathematics teachers from using ALSs in their teaching of mathematics from their personal perspective?" The interviews were carried out according to the following qualitative research methodology:

1. The participants were contacted to schedule an appropriate date for the interview.
2. They were informed about the study's purpose and assured that their data would be confidential and used only for scientific research. Appropriate settings were provided out of respect and appreciation for the interviewees. The interviewees were interviewed individually; their responses were written verbatim on paper without addition or omission. The duration of the interviews ranged between 15–25 minutes.

4. Results

Data were analysed and coded using qualitative research approach. All answers were examined separately, carefully, and critically several times to extract the necessary information. The information was encoded and organised in the order in which it was relayed in the interviews. The axial coding process was performed by extracting the main ideas following open coding and noting any general features. Sub-ideas were then identified. Finally, the authors ensured that the sub-ideas were just as they had been presented by the interviewee.

4.1 Findings related to the first research question

Recall that the first research question for this study is: "To what degree do secondary-level public school mathematics teachers in the city of Amman use ALSs?" The descriptive analysis of the participants' responses regarding the degree to which they used five different ALSs is presented in Table 4.

Table 4: The results of the descriptive analysis regarding the degree of using ALSs

Rank	*N*	Strategy	*M*	*SD*	Degree
1	5	Brainstorming	3.65	.699	Medium
5	1	Cooperative learning	3.64	.816	Medium
2	2	Problem-based	3.40	.748	Medium
3	3	Discovery-based learning	3.35	.745	Medium
4	4	Project-based learning	3.27	.762	Medium

The arithmetic means for the strategies ranged from 3.27 to 3.65. The brainstorming method placed first with the highest mean (3.65), while the project-based learning strategy ranked last (3.27). Overall, the findings indicated that the participants' use of ALSs was at a medium level. The authors attribute this result to the fact that the participants still use conventional instruction methods such as direct teaching, lecturing, and indoctrination as a result of overcrowding in the classrooms, the lack of educational means and technologies, and the time and effort involved in implementing ALSs.

Some of the participants may not have been familiar with ALSs, while others may have been afraid of losing control over the classroom because such strategies require more preparation and higher levels of thinking. In addition, students' lack motivation, negative attitudes toward mathematics, and lack of interest in ALSs (principally because many secondary school students have private lessons) may have played a part. It also appears that ALSs are not prioritized in pre-and in-service teacher training programs, which would militate against their use in the classroom. The above findings are consistent with Al-Balawi (2019), who observed a medium-level use of ALSs, but not Dabash (2022), Medini (2021), and Zerouali (2020), whose studies revealed a high degree of use.

4.2 Findings related to the second research question

Recall that the second research question for this study is: "Does the degree of use of ALSs by secondary-level public school mathematics teachers in the city of Amman differ according to the variables gender, academic qualification, and teaching experience?" The descriptive analysis of the participants' responses related to the impact of gender, academic qualification, and experience on the degree of using ALSs is presented in Table 5.

Table 5: Results of the descriptive analysis by gender, academic qualification, and experience

Gender/qualification/ experience			Cooperative learning	Problem-based learning	Discovery-based learning	Project-based learning	Brainstorming strategy
Gender	Male	*M*	3.54	3.32	3.27	3.22	3.56
		SD	.902	.843	.833	.825	.812
	Female	*M*	3.72	3.46	3.41	3.31	3.72
		SD	.739	.665	.669	.713	.595
Qual.	BA	*M*	3.70	3.47	3.39	3.32	3.72
		SD	.744	.623	.650	.661	.551
	Postgrad.	*M*	3.53	3.27	3.27	3.19	3.53
		SD	.924	.920	.888	.912	.895
Exp.	< 5yrs.	*M*	3.82	3.60	3.43	3.47	3.79
		SD	.824	.616	.671	.620	.578
	5–10 yrs.	*M*	3.69	3.40	3.40	3.34	3.63
		SD	.715	.745	.737	.801	.761
	> 10 yrs.	*M*	3.58	3.34	3.30	3.19	3.63
		SD	.851	.775	.769	.771	.701

There was a significant difference in the means and standard deviations of the degree to which the participants used ALSs in relation to gender, academic qualification, and teaching experience. A three-way ANOVA was used to show the significance of the statistical differences between the means of the participants' responses (Table 6).

Table 6: The results of the three-way ANOVA

Source of variance	**Strategy**	***SS***	***DF***	***MS***	***F* value**	***p* value**
Gender	Cooperative	1.824	1	1.824	2.782	.097
	Problem-based	1.009	1	1.009	1.837	.177
	Discovery-based	1.154	1	1.154	2.081	.150
	Project-based	.380	1	.380	.660	.417
	Brainstorming	1.466	1	1.466	3.053	.082

Source of variance	Strategy	*SS*	*DF*	*MS*	*F* value	*p* value
Qualification	Cooperative	.940	1	.940	1.434	.232
	Problem-based	1.451	1	1.451	2.642	.105
	Discovery-based	.474	1	.474	.855	.356
	Project-based	.506	1	.506	.880	.349
	Brainstorming	1.516	1	1.516	3.158	.077
Experience	Cooperative	1.562	2	.781	1.191	.306
	Problem-based	1.530	2	.765	1.394	.250
	Discovery-based	.546	2	.273	.492	.612
	Project-based	2.411	2	1.205	2.095	.125
	Brainstorming	.581	2	.290	.605	.547
Error	Cooperative	154.762	236	.656		
	Problem-based	129.572	236	.549		
	Discovery-based	130.869	236	.555		
	Project-based	135.790	236	.575		
	Brainstorming	113.336	236	.480		
Overall	Cooperative	159.652	240			
	Problem-based	134.222	240			
	Discovery-based	133.284	240			
	Project-based	139.524	240			
	Brainstorming	117.389	240			

The results show the following: (i) No statistically significant gender differences ($\alpha = 0.05$), (ii) No statistically significant qualification differences ($\alpha = 0.05$), and (iii) No statistically significant teaching experience differences ($\alpha = 0.05$). These findings were due to the fact that the nature of work in public schools in Jordan generally, and in the city of Amman in particular, is similar in terms of the requirements of the profession, and that the educational environment in which the teachers work is the same in terms of capabilities, conditions, data, and obstacles. Additionally, the participants were all mathematics teachers in public schools, so no differences were found when the study's variables were considered. These findings accord with Dabash (2022), who showed no statistically significant differences in the degree of use attributed to the study variables. By contrast, Zerouali (2020) did note some differences.

4.3 Findings related to the third research question

Recall that the third research question for this study is: "What obstacles prevent secondary-level public school mathematics teachers in the city of Amman from using ALSs?" The interviewees' responses were used to answer this question. The participants reported teacher-, student-, curriculum-, subject-, and school environment-related obstacles.

A. Teacher-related obstacles

The interviewees' responses showed the following teacher-related obstacles:

- Poor knowledge of ALSs and how they should be applied
- Moor time is required for applying ALSs
- More effort is required in planning and preparing lessons
- Controlling the class is difficult when using ALSs
- Teachers' lack of conviction
- The requirements exceeded the teachers' capacity (e.g., lengthy curricula, additional exercise books, supporting material, remedial interventions, and excessive quorum)
- The time allotted for the subject prevented the teachers from employing ALSs

B. Student-related obstacles

The interviewees' responses showed the following student-related obstacles:

- Students' poor academic level did not encourage teachers to use ALSs
- Students lacked awareness of their roles
- Weak motivation and negative attitudes towards mathematics in general
- Lack of belief in the significance of ALSs
- Most students depended on private lessons and were not interested in class
- Students preferred conventional methods, such as indoctrination, lectures, and direct instruction because they were easier and generated better results more quickly
- Individual differences amongst students impeded
- Students could not adapt to an active learning environment and comply with its requirements
- Students lacked interest and did not cooperate when teachers were using ALSs
- Some students were not convinced of the importance and effectiveness of ALSs
- Students wanted to complete the course as quickly as possible, and they felt that strategies other than direct teaching were a waste of time and required more effort

C. Curriculum and subject-related obstacles

The interviewees' responses showed the following subject-related obstacles from their perspective:

- The momentum of the curriculum and the intensity of its content
- Many mathematics topics hinder the use of ALSs
- Lack of mathematics activities that might enhance interaction between students in an active learning environment
- The mathematics teacher's guide does not explain how to use ALSs
- The presentation of mathematics topics lacks any element of suspense and excitement, which hinders the use of ALSs

D. School environment-related obstacles

The interviewees' responses showed the following environment -related obstacles:

- Lack of school materials, teaching aids, and learning resources
- Insufficient class time
- Teachers' overload
- Overcrowded classes
- Restricted classroom space and poor design
- Too many administrative responsibilities assigned to the teachers
- Systems of evaluation and multiple testing are not commensurate with ALSs

5. Discussion

One of the challenges of teaching mathematics is to present the material in an engaging way to make it accessible to as many students as possible. Given the fact that active learning leads to more engaged students who learn mathematics by doing mathematics (Sibona and Pourreza 2018); learning environment should be pushing active learning strategies regardless of classroom environments, teacher qualification and experience, or curriculum materials.

Findings form the present study revealed that some barriers inhibited math teachers in the city of Amman from implementing ALSs related to teacher, student, subject, curriculum, and school environment. The lengthy curriculum, time-consuming remedial material, and condensed semesters were among the issues reported by several interviewees. They stated that "the students want to complete the curriculum as fast as possible"; "the teachers feel that all strategies except direct instruction are a waste of time" and "the space does not allow for group work." Others mentioned the "students' weakness in the fundamentals," "the great disparity in students' levels of proficiency and the below-standard performance of the majority of the class," "the dependence of students on a private tutor so they can dispense with the school teacher," "a large number of students in the classroom," " modest provision," "a lack of resources, tools, and support for teachers," "negative attitudes toward mathematics ," and "an abundance of sub-skills that exceed the learning outcomes."

Mathematics Obstacles also included "the lack of knowledge of the subject by the teacher and the learner," "the high workload of the teacher in terms of the number of classes and other tasks assigned to them," "a lack of motivation amongst students," "a weak general attitude amongst students towards mathematics," "students' moodiness and unwillingness to take part in group work," and "a lack of adequate infrastructure and facilities in most schools." mathematics

Some participants referred to the "teachers' lack of conviction in this method in mathematics," "a lack of expertise of how to employ ALSs," "the pressure of the content and the depth of the scientific information," "insufficient time," and the fact that "the students haven't been taught this way before, which makes it difficult to apply." It may be the case that teachers and students still prefer traditional teaching methods such as lectures, indoctrination, and direct instruction because they are simple to use, produce quick results, and are appropriate for the learning environment. It must also be noted that more extensive preparation (both for teachers and students), sufficient and appropriate materials, conducive learning environments, and sound curriculum design are prerequisites for effective ALSs. These observations are consistent with Ghanim et al. (2020), who witnessed the same obstacles to implementation.

With the recent curriculum development project in Jordan, the mathematics curriculum provided some opportunities for teachers to apply ALSs such as project-based learning and problem-solving strategies. The developed mathematics curriculum allocates lessons for "problem-solving strategies" in which students learn several problem-solving strategies and use it to solve problems in different real and abstract contexts. However, not all mathematics teachers in Jordan have been trained after developing the curricula on both the mathematical content knowledge and pedagogical knowledge required to teach the developed books effectively. Moreover, classrooms have not yet been equipped with sensory aids that help teachers implement active science strategies. The importance of the present study lies in identifying the most significant challenges mathematics teachers in Jordan face when implementing ALSs, thus contributing to their mitigation. Also, bringing to the attention of the Ministry of Education the necessity of creating an educational environment in schools that support active learning methodologies, and making mathematics teachers aware of the value of incorporating ALSs into their practice for their students.

6. Conclusions

In light of the present study's findings, the authors recommend that closer attention needs to be paid to mathematics teachers' professional development, equipping them with contemporary teaching methods, training them on both the mathematical content knowledge and pedagogical knowledge required to apply ALSs in their teaching practices, and incentivizing their use by lightening their workload. The authors also suggest focusing on improving the learning environment in public schools, including the design of school buildings, classroom space, access to school equipment and facilities, overcrowding in classrooms, diversifying learning resources, and offering suitable educational means, materials, and techniques for applying learning strategies mathematics

The study has several limitations. For example, it only identified the use of ALSs amongst mathematics teachers working in public schools in the city of Amman, the degree of teachers' use of these strategies, and the obstacles that prevent their use in the classroom. Future researchers might study the application of ALSs in different geographic and subject contexts.

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