The Impact of Instruction-Based LEGO WeDo 2.0 Robotic and Hypermedia on Students' Intrinsic Motivation to Learn Science

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Abstract—Robots and hypermedia have been used as effective technological tools in the educational field. Despite their educational benefits, there are no studies investigating their impact on primary students' intrinsic motivation in the field of science. For these reasons, the study aims to recognize the impact of employing LEGO WeDo 2.0 robotic and hypermedia on intrinsic motivation to learn science among primary students. The study implemented the quasi-experimental approach with a dual group design. The experimental group (n=25) was instructed on the force and motion topic using instruction-based LEGO WeDo 2.0 robotic and hypermedia, while the control group (n=25) was instructed using traditional instruction. The study conducted in Jordan involved fifty primary students. The data was gathered by administering the developed Intrinsic Motivation Towards Learning Science Scale to both groups at pre and post-points; ANCOVA analysis revealed a significant effect in favor of the experimental group in increasing intrinsic motivation to learn science at $\alpha = 0.05$. These results recommend science instructors employ robots and hypermedia to foster students' intrinsic motivation. It also encourages decision-makers in educational institutions to make decisions related to the science curriculum and its instructional methods.

Keywords—robot, hypermedia, intrinsic motivation, science, instruction

1 Introduction

The rapid growth of technology in the twenty-first century imposed on educational institutions the need to integrate learning environments and instructional methods with digital tools to enhance the learning and teaching processes. Therefore, researchers have been conducting studies that employ several technological tools in several disciplines at K-12 and higher education levels, such as robots and hypermedia. The use of technological tools in education was not limited to enhancing the cognitive and skill aspects but also included the psychological ones such as motivation, which is one of the learning conditions and the most prominent factor affecting human behavior and the learning process. It is the force that motivates behaviors and directs them toward achieving the goal [1]. It helps in acquiring knowledge and skills [2-3]. Due to the important role of motivation in the learning process, researchers have conducted many studies that involved motivation among students across all subjects.

The importance of motivation for learning sciences comes from the importance of science education, which is considered the most integral part of today's education [4]. It constructs the scientific culture and prepares productive individuals for society. Consequently, there has been an excessive concentration on technological tools that foster motivation toward learning science. Interest in introducing robotics into science education has rapidly grown over the past few years. It has several advantages such as developing a conceptual understanding of scientific concepts; fostering student collaboration; motivation; interest in learning science and problem-solving [5-12]. Also, Hypermedia was integrated into learning science, which is a combination of hypertext and multimedia elements [8]. Teachers employ it in science curricula regarding its benefits in improving students' learning, self-regulated learning, scientific processing skills, acquisition of scientific concepts, problem-solving skills, and students' motivation [12–15]. Consequently, integrated robotics with hypermedia could improve learning science and students' motivation towards it among all students.

Despite the several global reform movements that appeared in science curricula there are notable worldwide weakening in enrollment, academic results, attitude, and motivation in the science learning context [16-18]. More precisely, in Jordan, the outcomes of the Trend in International Mathematics and Science Study (TIMSS) test discovered weaknesses in science among Jordanian students [19]. As well, fifth-grade are within the stage of concrete operations stage according to Piaget's classification; they, as they face difficulty in verbal reasoning and cannot form abstract concepts. They are unable to think logically unless it is linked to sensory experiences [20-21]. Therefore, they need higher motivation to learn science and its concepts; Further, no conducted study in the literature examines the impact of employing robots and hypermedia on students' intrinsic motivation to learn science. These shed light on the need to conduct new researches that examine the effect of employing robot with hypermedia in boosting the motivation to learn science among primary students. Therefore, this study could bridge the gap in motivation to learn science literature related to robots and hypermedia and it could encourage science instructors to employ good practices to enhance students' intrinsic motivation.

This study aims to reveal the impact of using robots and hypermedia instruction in developing intrinsic motivation toward learning science among fifth-grade students in Jordan. This study specifically attempts to answer the following question:Are there significant differences in the development of intrinsic motivation to learn science attributable to the instructional method (instruction-based LEGO WeDo 2.0 robotic and hypermedia vs. traditional) at the significance level ($\alpha < 0.05$)?

The following section reviews the theoretical frameworks of the research and the state-of-the-art literature that have investigated students' intrinsic motivation to learn science, the next section introduces our methodology, then the findings of the research were presented and discussed, finally the research ends with a conclusion, limitations of the study and some recommendations for future researches.

2 Literature review and theoretical framework

2.1 Motivation and learning in a science context

Motivation has a vital role in an effective learning and teaching process. It has attracted the attention of several researchers and psychologists across numerous contexts. There is no single definition of motivation. It is conceptualized as an internal construct that initiates, changes, or sustains goals, actions, and preferences. It is the power that stimulates the learner to handle all learning complications, difficulties, and challenges. It enables learners to realize their goals by engaging them in learning tasks [22-25]. Motivation is considered the underlying reason for an individual's behavior [26] and is associated with learning outcomes and academic activities [27-29]. It reflects students' engagement and learning involvement. Low-motivated students should be encouraged to participate and engage in learning activities [30], but how students' motivation can be provoked still preoccupies researchers, educators, and psychologists till now [31].

Many theories explain motivation, such as the Self-determination Theory (STD), according to it there are two types of motivation; a) intrinsic motivation where an inner force that motivates individuals such as interest and enjoyment, b) extrinsic motivation, where the individual's motivated by external contingencies such as rewards or punishments. Intrinsic motivation to learn involves engaging in learning tasks for the reason that they are seen as enjoyable, interesting, or related to achieving individuals' essential psychological needs [32]. In light of STD fulfillment of basic psychological needs (ie. autonomy, relatedness, and competence) in the educational environment works to develop the intrinsic motivation of students toward their learning, then they become more self-determined so they accept educational tasks with more comfort, In turn, intrinsic motivation encourages high-quality learning [32- 37]. This shows how important it is for the teacher and the instructional designer to meet students' needs and boost their intrinsic motivation to learn in all subjects.

The researchers began employing many strategies, models, and technological tools in an attempt to improve motivation quality among students at all levels of education using several tools. On the other hand, several factors impact students' motivation, such as teaching methods, administrative practices, and the school environment [20]. The teacher should be raising students' interest in the subject of learning and encourage students' participation.

Study findings have confirmed that students struggle and face difficulty understanding science, especially the basic physical concepts because some of them are connected to other concepts that make it more difficult to understand and conceive by students [37-38]. Besides, according to Piaget's cognitive development theory, abstract concepts are difficult to comprehend in primary students because they are in the concrete operational stage, they can resolve problems related to concrete concepts [39]. As a result, primary students require increased effort and motivation to conceptualize abstract concepts and learn science. Difficulties in learning science can be overcome using appropriate practice and instructional strategies by instructors [37]. Therefore, researchers should integrate technology to motivate students and simulate abstract concepts to enhance science learning. Consequently, Kommers [40] recommends using metaphors.

Ajlouni and Jaradat recommended using hypermedia to offer simulation for abstract concepts [12], while Badeleh and others used robots to motivate and engage students in learning science [41-42].

2.2 Robots and learning science subjects

The robot attracted the consideration of educators and researchers in educational settings across the world. Some countries focused on employing robots to support learning STEM curricula; in other countries, robot-based curricula were limited to school robot camps, after-school activities, and enrichment classes [43]. In general, the Robot Olympiad appeared in most countries, and its national and international competitions were spread to encourage students to learn STEM subjects [44]. A robot is defined as a device that has sensors and can be programmed [45]. It is a computer-controlled machine that can sense, hold, and move objects [46]. The term "educational robot" (ER) refers to a specialized field in which three different experiences intersect; robotics, pedagogy, and psychology.

Several types of educational robots have emerged, which vary in their form, equipment, software systems, and behavioral products [47]. Educational robots are classified into two main categories: use bots such as turtles and build bots such as LEGO robots [48]. However, they are used in the educational context based on the research of Papert, Vygotsky, and Jean Piaget to build meaningful learning experiences [49]. Catlin and Balmires also made guidelines for Educational Robotic Applications (ERA) that tell designers and teachers how to use robots in the classroom [50].

Literature on Educational Robots points out numerous benefits to employing them in the learning and teaching processes. They provide an active environment that facilitates learning by doing, provides a fun and engaging learning environment, opportunities to employ scientific skills and knowledge in a meaningful way, and enhances motivation to learn, imagination, achievements, and the acquisition of scientific concepts; develops digital competencies and an understanding of STEM topics [51-60].

Previous studies indicated the possibility of employing the robot and mastering its programming skills in different age groups, starting with pre-kindergarten children [61-64]. Therefore, educators and researchers integrate robots into teaching and learning in several disciplines across several age groups [65]. Despite this, the conducted studies that investigated the impact of employing robots on motivation in science subjects at the primary school stage were characterized by scarcity. There is also no study in the Arabian context. Therefore, this study relied on conducted studies that employed it among different age groups of students across different countries, for example, in Italy [66] they conducted a study that integrated robots to teach physics concepts to high-school students. The result showed a significant enhancement in the student's understanding of physics concepts and principles. Also, Elaz [67] conducted an experimental study among fifth-grade students, the study's findings revealed a positive impact of employing LEGO WeDo 2.0 robotics on students' attitudes and science achievements. As well, in the United States [68] conducted a study that employed robots in teaching undergraduate general physics, the findings of the study found that the activities of robot-building and programming enhance group learning skills to learn physics concepts and foster students' motivation. Similarly, [69] conducted a study in Spain that found robots enhanced interest, scientific curiosity, and social skills among secondary school students. Further, [70] conducted a quantitative and qualitative study method among high school students that revealed participation in a robotics workshop increases student motivation to learn physics. In Turkey, [71] found that robotic education can help high school students with their science performance and enhance students' relationships. In Jordan, [72] found that integrating hypermedia with robots enhances the acquisition of physical concepts among primary students.

2.3 Hypermedia and learning science subjects

Researchers recognized hypermedia in the educational field as an effective technological tool and considered it an extension of multimedia. Hypermedia is a combination of hypertext and multimedia elements [8]. It is also defined as storing and organizing elements that include text, images, sound, and animation in a complex way that allows nonlinear navigation [73]. Hypermedia is an effective technique for recognizing learners' differences such as learning styles and abilities [74].

The literature on hypermedia reports several benefits of using it in education, such as supports: Individual, constructivist, and Collaborative learning [75]. Hypermedia could take into account individual differences and stimulate students' motivation toward learning [76]. Further, it supports various skills such as metacognition, planning and control skills, self-regulated learning, students' independence, and problem-solving skills [1], [77-79]. Besides this, it has all the educational advantages of multimedia [75]. Theng [80] indicated that designing successful learning experiences in a hypermedia environment requires the designer of hypermedia to achieve the principles of desire to learn, learning by doing, providing feedback, and easing content comprehension [11]. Furthermore, [10] stated that hypermedia designers should consider the cognitive pattern because independent students require higher levels of control while browsing the hypermedia environment, whereas students who are dependent on their learning require support, such as more guidance while browsing. Other researchers proposed principles for designing instructional hypermedia to help designers simulate students' learning patterns [11]. Thus, to take advantage of the capabilities of hypermedia in the educational process, the designer of educational hypermedia must take advantage of the technical capabilities and take into account the challenges facing the hypermedia learning environment. As a result, educators should use well-designed hypermedia that adheres to instructional hypermedia principles because hypermedia design is the foundation of being an effective learning tool or causing students to lose focus and attention, distracting them from learning and increasing their cognitive load.

Researchers conducted studies that investigated the impact of integrating hypermedia in several disciplines [81. For example, [82] conducted pre-experimental research using one group design to study the impact of using hypermedia on students' attitudes toward learning physics and problem-solving skills. The study involved thirty-one students from Universitas Muhammadiyah Makassar. The results revealed that hypermedia improved students' problem-solving skills and they were happy with using it in physics learning. Further, [83] directed a study to reveal the impact of inquiry-based hypermedia on higher thinking skills among eleventh-grade students in physics. The study was based on a quasi-experimental method with dual design groups, including fifty-four students. The results revealed that hypermedia enhanced higher thinking skills as students had a positive response through learning using hypermedia. Also, [84] conducted a study in Nigeria to investigate the impact of hypermedia on the academic performance of high school students in chemistry. The research follows quasi-experimental methods and found that hypermedia improves academic performance in chemistry and makes it more enjoyable. Further, [85] conducted qualitative research that studied the intervention of hypermedia based on VARK (visual, aural, read/write, and kinesthetic) learning styles in science education. It specified that taking into account pedagogy and differences in learning styles is very important to simplify students' acquisition of meaningful knowledge. In addition to that, the study by [12] revealed a positive impact of using hypermedia on the acquisition of scientific concepts among primary students in Jordan. Despite the importance of integrating robots and hypermedia into teaching and learning processes, there is no previous study that investigated their impact on primary students' intrinsic motivation towards learning science, this highlighted the need to conduct such a study, especially in an Arabian context.

In light of the above literature review and theoretical framework, the conceptual framework of this research was formulated and displayed in Figure 1. This study hypothesized that students' intrinsic motivation to learn science could be enhanced using good instruction and practice (ie. employing robots with hypermedia) that supports students' basic psychological needs such as autonomy, relatedness, and competence.

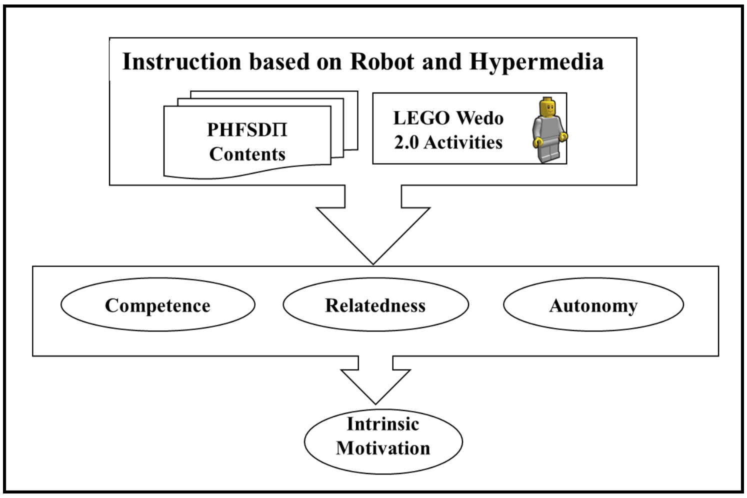

Fig. 1. Conceptual framework of the research

3 Methodology

The study implemented the quasi-experimental approach with a design of dual groups. The study sample was comprised of fifty students from grade five in one of the private schools in Amman. Their age ranged from 10–11 years on average. They were all female students. The private school was purposefully selected concerning the availability of required equipment, such as Wi-Fi and a smartboard. The pilot sample is comprised of forty-five fifth-grade students from another private school located in Amman. After getting permission from the Jordanian Ministry of Education, the study was conducted in the 2019-2020 school year.

The dependent variable of the study is student intrinsic motivation to learn science, while the independent variables are the instructional methods (traditional vs. LEGO WeDo 2.0 robotics and Hypermedia). The SPSS software was used to analyze the data and see how the instruction-based LEGO WeDo 2.0 robotics and Hypermedia affected students' motivation to learn science.

Two classes were randomly assigned into experimental groups (n=25) studied using instruction-based LEGO WeDo 2.0 robotic and Hypermedia and a control group (n=25) studied using traditional instruction. The Motivation Towards Learning Science (MTLSS) was applied to the members of groups before and after instruction on the topic of force and motion. Both groups were taught by the same science teacher for 18 hours over 2 months.

The robot used in this study is the LEGO WeDo 2.0 robotic kit, which is a suitable type of educational robot for students who do not have any experience in robotics and programming. Students use WeDo 2.0 Software to program and control the robot, which is a visual way of coding appropriate for primary students that depend on dragging icons and dropping them. The LEGO WeDo 2.0 robotic kit contains a Smart hub, a motor, a motion sensor, a tilt sensor, and 280 bricks. The robot activities used in this study were developed by [86]. It aligned with the science curriculum for the Ministry of education in Jordan. It was reviewed and approved by an expert as it was implemented on a pilot sample. It's effective in acquiring scientific concepts [72]. Each robotic activity contains worksheets, manuals, and reflection tasks. Besides this, the hypermedia used in this study is PHFSD∏, which was developed by [87] to teach the topic of force and motion to fifth-grade students. It was developed based on the science curriculum of the Ministry of Education in Jordan; PHFSD∏was designed according to the 6-D model. It has a very good quality [87] and is effective in acquiring scientific concepts [12]. It includes multi-content representations, non-linear control, as well as remedial and enrichment plans. Each lesson includes a set of instructional elements such as interactive presentations, instructional videos and games, a glossary, and assessments as well as group-based activities. It includes all the necessary materials, such as remedial, enrichment, and prerequisite.

Students who belong to the control group learn according to the traditional instruction method using science textbooks, paper-based worksheets, and science laboratory tools. They are learned in small groups during science class sessions. The science instructor used the smartboard for writing and presenting videos. While students who belong to an experimental group learn using the instruction-based LEGO WeDo 2.0

robotic and hypermedia, the students use PHFSD∏ nested within a science textbook. The instructor's role in the experimental group was restricted to facilitating the learning process through questioning, discussion, and help. The students were active and led the learning process, in which they can access PHFSD∏ at any time; they can use it outside the class sessions as well to recall their prerequisite knowledge, use enrichment materials, or practice. Students can use it according to their own learning pace. During class sessions, students learn in small groups, where each group has a LEGO WeDo 2.0 robotic kit and a tablet to access the PHFSD∏. Students work cooperatively to design, build, and program the robot and solve the worksheets.

3.1 Study instrument

The IMTLSS was developed based on literature related to intrinsic motivation and relevant motivation toward science scales [88-93]. It consisted of 23 items that measure the construct of students' intrinsic motivation toward learning science. It adopted the 4-Likert scale and requires approximately 35 minutes to respond to its items. The mean values of IMTLSS scores ranged between 1.0 and 2.0, representing a low level of motivation to learn science, 2.01–3 representing a moderate level, and 3.01–4.0 representing a high level.

The content validity of the IMTLSS was ensured by a panel of experts. The internal construction validity and reliability were also confirmed by administering the IMTLSS to a pilot sample of 45 primary students. Table 1 shows that the Pearson correlation coefficients (PCC) between each item and the total IMTLSS score ranged between 0.30 and 0.82 and were all significant. These results prove the internal consistency of IMTLSS. Also, researchers confirmed the reliability of the scale using the test-retest method. The PCC between the test and retest of Cronbach's alpha was 0.93. These values indicate that the IMTLSS is a reliable and valid scale.

Table 1. The Pearson correlation coefficients between each item and the total score of MTLSS

Item	PCC with a total score	Item	PCC with a total score
1	0.60**	13	0.80**
2	0.71**	14	0.82**
3	0.56**	15	0.68**
4	0.63**	16	0.64**
5	0.78**	17	0.72**
6	0.61**	18	0.60**
7	0.36*	19	0.36*
8	0.66**	20	0.65**
9	0.60**	21	0.71**
10	0.66**	22	0.73**
11	0.53**	23	0.30*
12	0.62**		

*: significant at $p<0.05$, **: significant at $p<0.01$.

3.2 Data analysis

The research question was answered by extracting the descriptive statistics and performing an ANCOVA test to inspect the impact of the instruction-based LEGO WeDo 2.0 robotic and hypermedia on developing intrinsic motivation toward learning science. The researcher extracted the Eta square to find out the effect size of the instructional method. The statistical analysis was performed using the SPSS program.

4 Results and discussion

To answer the research question: RQ: Are there significant differences in the development of intrinsic motivation towards learning science attributable to the instructional method instruction-based LEGO WeDo 2.0 robotic and Hypermedia vs. traditional) at the significance level ($\alpha < 0.05$)? The descriptive statistic Means and Standard deviations) of the study groups' responses on IMTLSS before and after the instruction, were extracted, and then ANCOVA analysis was performed. The two study groups' responses to IMTLSS before and after instruction are shown in Table 2.

Table 2. The descriptive statistics of Study Groups' Scores on MTLSS before and after the instruction

Group	Before Instruction	After Instruction
	M* ± *SD	***M* ± *SD***
Experimental (n=25)	2.9 ± 0.36	3.20 ± 0.24
Control (n=25)	2.9 ± 0.26	2.86 ± 0.25

Note. M: mean, SD: Standard Deviations.

The results presented in Table 2 indicate that the student's intrinsic motivation levels for learning science for the two study groups before the instruction were similar, as the mean of the control group's scores on the IMTLSS was similar to that of the experimental group, which reached (2.9). The means of the IMTLSS scores for both groups after the instruction showed that there were apparent differences in the students' intrinsic motivation level, as the mean for the members of the experimental group that learned using LEGO WeDo 2.0 robotic and hypermedia instruction was (3.20), with a difference of (0.34) score in favor of the experimental group students. The ANCOVA method was used to determine whether the differences in mean values between the two groups are statistically significant at the level ($\alpha < 0.05$). Also, the Eta square was extracted to know the effect size of the instructional method on developing intrinsic motivation towards learning science. Table 3 shows the ANCOVA results.

Table 3. ANCOVA analysis of Study Groups‘ Scores on IMTLSS after instruction

Source of Variation	Sum Square	Df	Mean Square	F	Sig	(η2)
Before Instruction	2.475	1	2.475	343.444	0.000	0.880
Instructional Method	1.444	1	1.444	200.420	0.000	0.810
Error	0.339	47	0.007			
Adjusted Total	4.236	49				

Note. Sig: significant, Df: degrees of freedom, F: F-test, and η2: Eta square.

Table 3 shows that students' IMTLSS scores after instruction differ significantly ($\alpha < 0.05$) between instructional methods ($F = 200.420$, $P = 0.000$), indicating that instructional methods influence students' intrinsic motivation to learn science. It was also clear from the data in Table 3 that there was an effect of the instructional methods on the intrinsic motivation towards learning science, as the Eta square amounted to (0.81), which indicates that 81% of the variation in the intrinsic motivation towards learning science among the study groups is attributable to the method of instruction. To find out which instructional methods were favored, the adjusted means of two study groups' scores on IMTLSS after the instruction were extracted and appear in Table 4.

Table 4. Adjusted Means and Standard Errors of IMTLSS Scores after instruction

Group	AM	SE
Experimental	3.20	0.02
Control	2.86	0.02

Note. SE: Standard Error and AM: Adjusted Means.

It was found that the adjusted mean of IMTLSS for students in the experimental group was (3.20), which is greater than the students in the control group who learned in the traditional method (2.86). It means that the experimental group's students who learned using the LEGO WeDo 2.0 robotic and hypermedia kit had a higher level of motivation. This indicates that the use of LEGO WeDo 2.0 robotic and Hypermedia in science instruction has a positive impact on raising the level of students' intrinsic motivation towards learning science.

The researcher attributes this positive impact to a set of factors, most notably that the instruction-based LEGO WeDo 2.0 robotic and hypermedia provides an active technological learning environment that supports basic psychological needs (ie. autonomy, competent, relatedness) that stimulates students' intrinsic motivation to learn science. First, the robot activities include experiences based on team and group work. These activities provide a cooperative working environment that satisfies students' needs for relatedness, so they can communicate and interact with each other and with the environment around them. Satisfaction of relatedness contributes to enhanced self-determination among students that improve students' intrinsic motivation [33-34]. Additionally, Hypermedia provides nonlinear navigation that provides the ability to move between the learning contents, allowing students to learn according to their abilities. For example, students can replay any part of the videos and instructional games until they master and understand the relevant content which supports their need for competence. Moreover, hypermedia provides multiple content representations that evoke visual and audio channels that minimize their cognitive load and facilitate their learning [94]. Hypermedia also provides simulation for abstract physical concepts that help primary students in their concrete operations stage to comprehend and learn the concepts effectively [21,39]. The verbal reinforcement methods contained in the hypermedia elements, games, lessons, and computerized tests encourage students to continue the learning process and move forward with it, which contributes to enhancing their competence needs and then raising their intrinsic motivation to learn science. Moreover, hypermedia provides several options for control and opportunities to repeat the instructional elements, such as games, videos, exercises, and computerized tests, which contribute to raising their self-efficacy and competence in learning science, this helps make an individual more intrinsically motivated [35-37].

The hypermedia and robotic activities provide multiple opportunities for choice and flexibility that support the need for autonomy. Also, Hypermedia provides multiple content representations, alternative elements, additional links, and various methods of navigation and control that allow students to participate in the choice of representation of content that is consistent with their learning style and to choose the learning time. Students have the option to learn at the time and place they want, and we provide them with diversified content, which encourages them to engage in self-learning and supports their autonomy, which contributes to raising motivation, as it is one of an individual's basic psychological needs [35-37]. On the other hand, the robot activities provide students with several options to choose their group and role, as well as to think freely about doing tasks, including designing, building, and programming the robot to find the optimal solution. Freedom of choice motivates students to learn and keep trying until they reach their goals, and it also helps them learn how to learn on their own [95]. These factors support satisfying the basic psychological needs of the students which in turn makes them more intrinsically motivated.

This finding is in line with the results of previous studies [65-70] that found the use of robots in learning science had a positive attitude among students, fueled motivation, and enhanced interest and scientific curiosity. Also, this result is consistent with the findings by [82-84] that revealed employing hypermedia in learning science had a positive impact where the students had a positive response through learning with hypermedia, enjoyed learning, and became happy. So, the instruction-based robot and hypermedia make it more motivated for primary school students to learn science.

5 Conclusions

The novelty of this study is that it is the first one that investigates the impact of using LEGO WeDo 2.0 robotic and hypermedia instruction in developing intrinsic motivation toward learning science. It has contributed to filling a gap in educational literature related to intrinsic motivation to learn science. The study was applied to fifty students from a grade five private school located in Jordan. The study implemented a quasi-experimental design with dual groups. The control group learned the subject of force and motion using traditional instruction, whereas the students of the experimental group learned the same topic using LEGO WeDo 2.0 robotic and PHFSD∏. The study's findings proved the existence of a significant impact of using instruction-based LEGO WeDo 2.0 robotic and Hypermedia in developing the intrinsic motivation toward learning science.

Employing an educational robot with hypermedia in science learning provided incredible educational benefits that combined the advantages of hypermedia and educational robots. It gave students a fun and active place to learn science by giving them many options for how they wanted to learn, taking into account their different learning styles and abilities, their independence in learning, and raising their autonomy and competence. All of these things helped students meet their basic psychological needs, which made them intrinsically motivated to learn science.

The study's limitations related to the study sample were first, the sample size was 50 students from one private school. second, the sample of the study is comprised of female students only because most schools in Jordan separate male and female students according to the culture of Jordanian society. These limitations encourage researchers in the field of education to repeat the study on male students and to conduct further studies that examine the impact of using hypermedia and robots in developing intrinsic motivation toward learning science among other samples.

The findings of the study encourage science teachers to employ LEGO WeDo 2.0 robotic and Hypermedia to enhance students' intrinsic motivation. The results of the study also provide information for decision-makers in educational institutions that helps them make decisions related to the science curriculum and its instructional methods.

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