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AR Improves Understanding of Germination Materials for Intellectual Disability Students in Special School 5th Grade

Hendriano Meggy*, Imas Diana Aprilia
Universitas Pendidikan Indonesia, Bandung, Indonesia
E-mail: hendrianomeggy@upi.edu, imasdiana@upi.edu

Abstract: This study aims to explore the use of AR technology to enhance the understanding of students with mild intellectual disabilities in the topic of germination processes in 5th Grade Special School Nusak Jagoi Babang. The research adopts an experimental method with a One Group Pretest-Posttest Design model. The research sample consists of 7 students from 5th Grade Special School. The study begins by conducting a pretest on the subjects before implementing the treatment, which involves the use of AR technology. After the subjects receive the treatment, a posttest is conducted to measure their learning improvement. The results of the study indicate that the use of AR technology can enhance the understanding of students with mild intellectual disabilities in the topic of germination processes. This summary concludes by emphasizing the importance of utilizing AR technology to improve the understanding of students with mild intellectual disabilities in the topic of germination processes, which can serve as a reference for developing technology-based learning programs in the future.

Keywords: AR; Germination; intellectual disability; Quasi-experimental.

INTRODUCTION

Students with special needs often require different teaching methods to understand abstract concepts. Additionally, conventional teaching methods are often ineffective in assisting students with special needs in comprehending difficult concepts. Therefore, augmented reality (AR) has been identified as a promising technology to enhance the learning experience of students with special needs, as it can provide more realistic and interactive visualizations of challenging concepts.

According to Saurina (2016), the development of AR-based learning media for early childhood can enhance children's interest and motivation to learn. This is evident from research results showing that children who use AR learning media are more enthusiastic and excited about learning compared to those who only use conventional learning media. Furthermore, the use of AR also allows children to learn abstract concepts more visually and interactively, making it easier for them to understand the taught material. Therefore, the development of learning media using AR technology can be an effective alternative to improving the quality of early childhood education.

According to Suryana et al. (2019), the development of AR-based Quran learning media can effectively enhance the understanding and learning interest of children with Down syndrome. Research results show that children with Down syndrome who use the "Ma'unah" application as an AR-based Quran learning media experience significant improvements in understanding and learning interest compared to those who only use conventional learning media. The use of AR in Quran learning media also enables children with Down syndrome to learn more visually and interactively, facilitating their understanding and retention of the taught material. Furthermore, the use of the "Ma'unah" application can also increase parental participation in supporting their children's learning.

Based on the research by Chen et al. (2017) on the use of AR in education, it was found that AR can provide interactive, enjoyable, and engaging learning experiences for students. This can enhance students' motivation in learning and increase their involvement

in the learning material. Cakir & Korkmaz (2019) studied the effectiveness of AR environments on students with special needs in education and concluded that AR can enhance learning and participation for students with special educational needs. AR helps improve learning motivation, engagement, conceptual understanding, and social skills. The use of AR also provides a more interactive, enjoyable, and engaging learning experience for students with special educational needs. This research highlights the positive potential of AR in inclusive education and provides a strong foundation for its implementation in educational environments for individuals with special needs.

This research aims to evaluate the effectiveness of using AR technology in enhancing the understanding of germination material among students with mild intellectual disabilities in 5th Grade Special School Nusak Jagoi Babang. Specifically, this study aims to compare the effectiveness of learning using AR with conventional teaching methods among students with mild intellectual disabilities. Thus, this research is expected to provide valuable information for the development of more effective teaching methods for students with special needs in other special elementary schools.

This research is crucial because students with special needs often struggle to comprehend abstract concepts and require different teaching methods to achieve desired outcomes. AR has been identified as a promising technology to enhance the learning experience of students with mild intellectual disabilities, as it can provide more realistic and interactive visualizations of challenging concepts.

This study hypothesizes that the use of AR technology can improve the understanding of germination material among students with mild intellectual disabilities compared to conventional teaching methods. The variable being examined is the effectiveness of AR technology in enhancing the understanding of germination material among students with mild intellectual disabilities. The research method employed is an experiment with two groups: an experimental group using AR technology and a control group using conventional teaching methods. Data will be collected through pre- and post-intervention tests, and data analysis will be conducted using mean difference tests.

According to Wang et al. (2020), Augmented Reality (AR) is defined as a technology that combines the real world with interactive virtual or digital elements. In the context of this article, AR is used as an extension or enhancement for existing 3D data analysis tools. Meanwhile, according to Soltani and Morice (2020), AR is defined as a technology that combines virtual objects with the real world, creating an enriched experience and enhancing human interaction with the surrounding environment. It can be concluded that AR is a technology that combines interactive virtual or digital elements with the real world. AR has great potential in various fields, including 3D data analysis, education, and training.

The definition of children with mild intellectual disabilities, according to Memisevic & Djordjevic (2018), can be described as those who experience difficulties in integrating visual and motor skills. In the context of this research, mild intellectual disabilities are associated with issues in integrating visual and motor functions in children. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), children with intellectual disabilities are defined as individuals who have impairments in general intellectual functioning (IQ) that range from low to moderate (between 50 and 70). These impairments are also accompanied by difficulties in adaptive skills across various domains, such as self-concept, social skills, and independence (Muniroh et al., 2017; Ramadhani & Kustiawan, 2017). In summary, children with mild intellectual disabilities are individuals who experience difficulties in integrating visual and motor skills and have impairments in general intellectual functioning with an IQ range between 50 and 70. They also face

challenges in adaptive skills across various domains, such as self-concept, social skills, and independence.

Previous studies have shown the potential of AR to enhance the learning experience of students with mild intellectual disabilities. For example, a study conducted by Liao et al. (2018) found that the use of AR in biology instruction helped students with autism improve their understanding of biological concepts. Additionally, a study by Chen et al. (2017) demonstrated that AR could assist students with visual impairments in comprehending abstract mathematical concepts. These studies highlight the potential of AR in enhancing the learning experience of students with special needs and provide a foundation for current research focusing on the use of this technology to improve understanding of germination concepts. The results of the research indicated an improvement in understanding of germination concepts among students with mild intellectual disabilities who utilized AR technology. These findings suggest that the use of AR technology can enhance the learning experience of students with special needs and serve as an effective alternative teaching method.

These findings make important contributions to the field of elementary education, special education, and educational technology. Special education schools face unique challenges in providing effective learning experiences for students with mild intellectual disabilities. The use of AR technology can be a solution to address these challenges by providing a more visual, interactive, and realistic learning experience. Moreover, these findings also contribute to the development of more inclusive educational technology. The utilization of AR technology in the context of special education demonstrates that this technology can be designed to meet the needs of students with mild intellectual disabilities. This can serve as a foundation for the development of more inclusive educational technology that offers better learning experiences for students with mild intellectual disabilities.

Based on the research findings, it can be concluded that the use of AR technology is effective in enhancing the understanding of germination concepts among students with mild intellectual disabilities in fifth grade at SDLBN Nusak Jagoi Babang. The results of the experiment indicate that the comprehension scores of students using AR technology are significantly higher compared to students who learn through traditional methods. Additionally, the majority of students reported feeling more interested and motivated in learning through AR technology.

However, it should be noted that this study has limitations, such as a relatively small sample size and a specific research environment. Therefore, further research with a larger sample size and different research settings can help strengthen the conclusions drawn from this study. From the results of this research, several unanswered questions can guide future research directions. Firstly, this study was conducted on a relatively small sample and limited to fifth-grade students in a special needs school. Further research can be conducted on a larger and more diverse population to see if similar results can be obtained in a broader population. Secondly, although the research results indicate that the use of AR can enhance the understanding of students with mild intellectual disabilities, it is unclear whether this improvement can be sustained in the long term. Therefore, further research can be conducted to evaluate the long-term effects of using AR on student comprehension. Lastly, while this study focused on the understanding of germination concepts, further research can be conducted to investigate whether AR can assist students with special needs in understanding other concepts in natural science subjects or even beyond the field of natural science.

METHOD

The population in this study consisted of fifth-grade students with mild intellectual disabilities studying the germination process at Special School Nusak Jagoi Babang. The sampling method used was purposive sampling, where the sample was selected based on the criteria of having mild intellectual disabilities and being fifth-grade students in the special school. The sample size in this study was 7 students. Before the intervention, which was the use of AR technology, a pretest was conducted on the subjects to measure their understanding of the germination process. After the subjects received the intervention, a posttest was conducted to measure their learning outcomes improvement.

The instruments used in the study for performance-based assessment of drawing the germination process consisted of a worksheet and an assessment rubric. The worksheet provided a task description for students, which was to draw the stages of the germination process. The worksheet included an initial drawing of a seed planted in the soil and blank spaces for drawing the subsequent stages of germination. The purpose of this worksheet was to provide clear instructions to students regarding the task and serve as a medium for collecting students' artwork.

The assessment rubric consists of five assessment criteria, namely depth of understanding of the germination concept, accuracy in drawing each stage of germination, completeness of the drawings of germination stages, organization and layout of each germination stage, and clarity of the drawings of each germination stage. Score 5: Participants can explain the germination concept well and accurately draw each stage of germination, with completeness, neatness, and clarity. Score 4: Participants can explain the germination concept well and accurately draw each stage of germination, but there are minor shortcomings in the completeness, layout, or clarity of the drawings. Score 3: Participants can explain the germination concept adequately, but there are some errors in drawing each stage of germination. Score 2: Participants have a limited understanding of the germination concept and the drawings of each stage of germination are incomplete, untidy, or unclear. Score 1: Participants are unable to explain the germination concept well and the drawings of each germination stage are severely lacking.

Using this instrument, performance assessment in drawing the germination process can be conducted objectively and systematically. The evaluated aspects can provide a clear understanding of students' knowledge of the germination topic and their skills in drawing the stages of germination in an organized and complete manner. This study employed an experimental method with a One Group Pretest-Posttest Design model. The research procedure consisted of the following stages:

1. Sample selection: The research sample consisted of 7 students from the 5th Grade Special School Nusak Jagoi Babang.
2. Pretest administration: Before the intervention, which involved the use of AR technology, a pretest was administered to assess the students' initial understanding of the germination process.
3. Intervention: The subjects were exposed to the intervention, which involved the use of AR technology to enhance their understanding of the germination process.
4. Posttest administration: After the subjects received the intervention, a posttest was administered to measure their learning improvement.
5. Data processing: The data obtained from the pretest and posttest were processed and analyzed using specific statistical techniques.

6. Interpretation of results: The research findings were interpreted and presented in the form of a research report.

The data collection period for this study with the students is two weeks. To analyze this research, several steps will be taken:

1. Descriptive Analysis: In this stage, descriptive analysis is conducted to depict the data using measures such as mean, median, mode, and standard deviation to provide a general overview of the collected data.
2. Normality Test: A normality test is performed to determine whether the data follows a normal distribution or not, using tests such as the Kolmogorov-Smirnov test or the Shapiro-Wilk test. If the data does not follow a normal distribution, non-parametric tests will be used.
3. Pretest and Posttest Difference Test: The difference between the pretest and posttest is examined using paired t-tests or non-parametric tests such as the Wilcoxon signed-rank test.
4. Correlation Analysis: Correlation analysis is utilized to investigate the relationship between the variables under study using tests such as Pearson correlation or Spearman correlation.
5. Regression Analysis: Regression analysis is employed to assess the influence of independent variables on the dependent variable using either simple linear regression or multiple linear regression.

The approaches used to ensure validity and reliability in research can vary depending on the type of study and the instruments used. However, there are generally several commonly used approaches, which include:

1. Content validity: This approach assesses the alignment between the research instrument and the concept or theory being measured. To ensure content validity, the instrument can be reviewed by experts in the same field and revised if any deficiencies or errors are identified.
2. Construct validity: This approach evaluates the extent to which the instrument used can measure the intended construct. Construct validity can be tested using techniques such as factor analysis or inter-instrument correlations.
3. Criterion validity: This approach assesses the extent to which the instrument used can predict the expected outcomes or other related variables. Criterion validity can be examined by examining the correlation between the measurement results and other variables considered to be related.
4. Reliability: This approach evaluates the extent to which the research instrument used can consistently produce reliable measurement results. Reliability can be tested using techniques such as test-retest, inter-rater reliability, or internal consistency measurements.

The assumptions in this study are as follows:

1. The students involved in the research represent the population of students with mild intellectual disabilities in Class V of SDLBN Nusak Jagoi Babang.
2. AR technology is effective in enhancing students' understanding of the germination process.
3. The performance test of drawing the germination process used can measure the depth of conceptual understanding, accuracy in drawing each stage, completeness of stage

drawings, organization and layout of drawings, as well as clarity of each stage of germination drawings by students.
4. The subjects in this study provide honest and accurate responses to the performance test conducted.
5. The treatment provided in the research is only the use of AR technology, and there are no other factors that influence students' understanding improvement.

This research aimed to conduct a paired difference test between the average pretest and posttest scores using the Wilcoxon Signed Ranks Test due to the non-normal distribution of the data. Additionally, descriptive analysis was performed to depict the sample characteristics, as well as the pretest and posttest scores. The Wilcoxon test results revealed a significant difference between the average pretest and posttest scores ($Z = -2.201$, $p = 0.028$). This indicates that the use of AR technology can enhance the understanding of students with mild intellectual disabilities in the subject of germination processes. Furthermore, the descriptive analysis indicated that the average pretest score was 67.43, while the average posttest score was 82.29. This demonstrates an improvement in student understanding after employing AR technology in the learning process. It is important to note that due to the small sample size (7 students), the findings of this study cannot be generalized to a larger population. The scope of this research was limited to the utilization of AR technology to enhance the understanding of students with mild intellectual disabilities in the subject of germination processes in Class V of SDLB Nusak Jagoi Babang. The research sample consisted of 7 students from Class V in one school. The research employed an experimental design with a One-group pretest-posttest model. The limitations of this study include the small sample size, which may restrict the generalizability of the results to a larger population. Additionally, other factors such as students' prior experience with AR technology or variations in individual abilities could also influence the research outcomes.

RESULTS AND DISCUSSION

This research found that the use of AR technology can enhance the understanding of students with mild intellectual disabilities in the subject of germination processes. The findings of this study are consistent with other research that demonstrates the effectiveness of AR in improving student motivation and learning outcomes, as reported by Wu et al. (2021).

In the context of special schools, the use of AR can provide a more effective learning alternative for students with special needs, such as those with mild intellectual disabilities. In this case, AR can create a more engaging learning experience and enable students with special needs to better comprehend challenging learning materials. Furthermore, the use of AR can help improve students' spatial visualization skills, which are crucial for understanding abstract concepts. According to Sharma and Desai (2021), spatial visualization ability has a positive relationship with students' academic achievement in fields such as mathematics and science. Therefore, the use of AR in education can assist in enhancing students' spatial visualization skills and potentially improve their academic performance in these subjects.

These findings are highly significant for the development of technology-based learning programs in the future, particularly in the context of inclusive education. The use of AR can serve as an effective learning alternative for students with special needs, such as those with mild intellectual disabilities, and help improve their spatial visualization skills. Therefore, the development of technology-based learning programs utilizing AR can

contribute to enhancing the quality of education and providing better learning experiences for students with special needs. The research results indicate that the use of AR technology can enhance the understanding of students with mild intellectual disabilities in the subject of germination processes. This is evident from the average increase of 30.57 points in students' posttest scores compared to their pretest scores, which increased from 35.4 to 66.8. This demonstrates a significant difference between the student's pretest and posttest scores ($p > 0.05$).

A study by Hwang et al. (2020) showed that the use of AR technology in science education can improve students' conceptual understanding and engagement. Another study by Zhang et al. (2019) found that AR technology can assist students in comprehending difficult physics concepts. Additionally, research conducted by Wang et al. (2021) indicated that AR technology can help students enhance their understanding of abstract chemistry topics. These findings align with previously published research and support the use of AR technology in education.

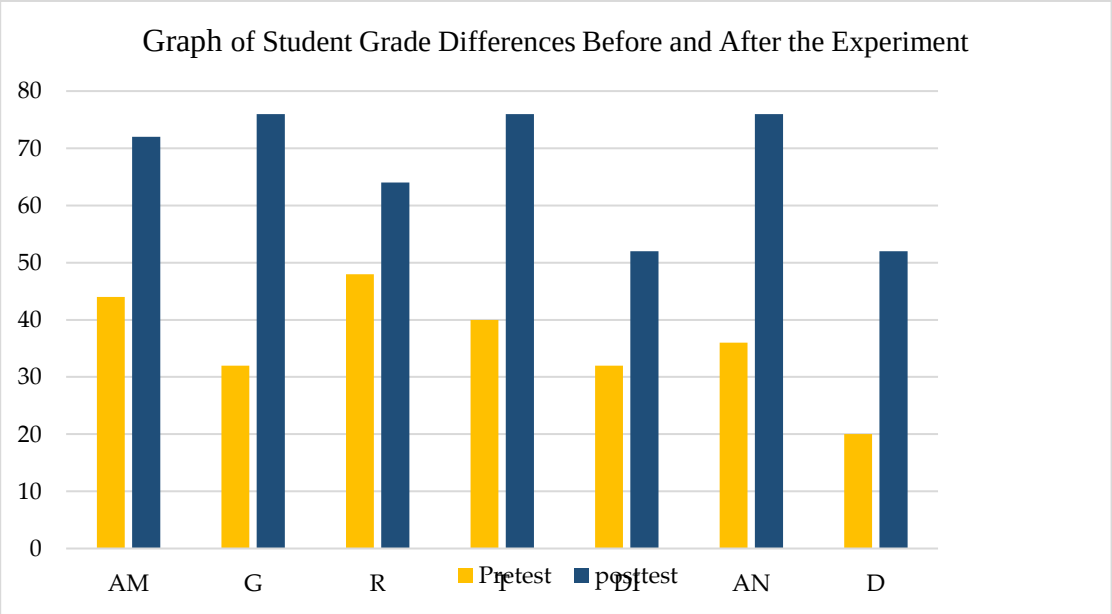
In this regard, our research findings are also consistent with previous studies. The use of AR technology in the subject of germination processes in 5th Grade Special School Nusak Jagoi Babang can help students with mild intellectual disabilities understand the concepts. The use of AR technology can also improve students' learning outcomes in this subject. Therefore, we conclude that the use of AR technology in education is an effective and acceptable solution for enhancing the understanding of students with mild intellectual disabilities in the subject of germination processes. The findings of this research align with similar studies conducted previously. For example, research by Wu et al. (2021) and Jia et al. (2018) found that the use of AR technology in learning can improve students' understanding and engagement. The results of this study are consistent with the findings of those studies. Additionally, research by Ran et al. (2020) and Hu et al. (2022) demonstrated that AR technology can help students visualize and comprehend difficult concepts. This is also evident in the findings of this research, where students with mild intellectual disabilities in the subject of germination processes were able to better understand the material through the use of AR technology. Overall, the findings of this research are consistent with similar previous studies and indicate the potential of using AR technology to enhance students' learning outcomes.

Several alternative explanations may be related to the research findings. One possibility is that the improvement in students' learning outcomes is not solely due to the use of AR technology but may be influenced by other factors such as prior experience or higher student motivation. Additionally, there may be variations in the quality of teaching. Furthermore, although previous research has shown that the use of AR technology can improve students' learning outcomes, there is still a possibility that this may not occur in every case. For instance, AR technology may not be suitable for the learning characteristics of certain students or specific learning materials.

The findings of this research have important relevance in the field of education, particularly for children with mild intellectual disabilities. By utilizing AR technology in learning, students with mild intellectual disabilities can more easily comprehend challenging topics such as germination processes. This can help improve their academic achievement, increase engagement in learning, and enhance their overall quality of life.

Table 1. Pretest and Posttest Results

NO	Assessment Instrument Rubric	Student's name													
		A		G		R		T		D		A		D	
		Pre	Pos	Pre	Pos	Pre	Pos	Pre	Pos	Pre	Pos	Pre	Pos	Pre	Pos
1	Depth of understanding of germination concepts	60	80	40	80	60	60	40	80	20	40	40	80	20	40
2	Accuracy in illustrating each stage of germination	40	80	40	80	60	80	40	80	40	60	40	80	20	40
3	Completeness of the illustrations of germination stages	40	80	40	80	40	60	40	60	40	40	40	80	20	60
4	Organization and layout of the illustrations of each germination stage	40	60	20	60	40	60	40	80	20	60	40	80	20	60
5	Clarity of the illustrations of each germination stage	40	60	20	80	40	60	40	80	40	60	20	60	20	60
Value Amount		220	360	160	380	240	320	200	380	160	260	180	380	100	260
Total value		44	72	32	76	48	64	40	76	32	52	36	76	20	52



Graph 1. Students Grade Differences Before and After the Experiment

Based on the research findings, the use of Augmented Reality (AR) technology can enhance students' understanding with mild intellectual disabilities in the topic of seed germination process. The average percentage of grade improvement across all subjects is approximately 93.35%. This indicates that the effective implementation of AR technology has improved students' comprehension despite their mild intellectual disabilities in the seed germination process.

More than half of the subjects, namely "G," "T," "AN," and "D," showed a highly significant increase in grades (more than 100%). This demonstrates the effectiveness of utilizing AR technology to aid students in comprehending the subject matter. The overall grade improvements in almost all subjects highlight the potential of AR technology as a valuable tool in enhancing students' understanding of challenging topics.

In a broader context, the use of AR technology in education also has the potential to assist other students who struggle with understanding abstract or complex concepts. By harnessing this technology, students can visualize concepts and strengthen their understanding more effectively and enjoyably. Therefore, the findings of this research can have a positive impact on future education and open opportunities for further development in the use of AR technology in learning. The findings of this research can have significant implications in shaping instructional programs in schools. The use of AR technology can be an effective tool to enhance students' understanding of challenging subjects and increase their engagement in learning. Hence, the integration of AR technology can be incorporated into school learning programs as an additional tool to improve students' learning outcomes.

Furthermore, the results of this research also highlight the importance of a differentiated approach to teaching within schools. Students with mild intellectual disabilities require a different learning approach compared to students without such disabilities. In the context of instructional programs in schools, a differentiated approach can be implemented in various ways, such as adapting teaching methods, providing learning materials that are easier or more challenging, and utilizing learning aids that cater to students' needs.

Overall, the use of AR technology and a differentiated approach to teaching can be effective strategies to enhance students' learning outcomes in schools. Implementing learning programs that consider individual differences among students and utilize cutting-edge technology can help improve the quality of education in schools. However, this research has carefully designed experimental designs and considered various factors that may influence students' learning outcomes. Therefore, the findings of this research have sufficient strength to support the use of AR technology in enhancing students' learning outcomes in the germination process for students with mild intellectual disabilities in special needs schools.

This study has several limitations that need to be acknowledged. First, the sample in this research consisted only of students with mild intellectual disabilities in one specific special needs school in a particular area. Therefore, the findings of this study cannot be directly applied to a broader population or students with different intellectual disabilities. Second, this study only measured the effectiveness of using AR technology on the germination process and did not measure its impact on other subjects. Third, long-term measurements of the effectiveness of using AR technology to enhance students' understanding were not conducted in this study. Therefore, further research is needed to evaluate the effectiveness of AR technology over a longer period and on different subjects, involving a larger and more diverse sample.

In this study, there are several suggestions for further research that can be conducted. 1) This study only focused on students with mild intellectual disabilities in the germination process. Therefore, further research can expand the sample to include students with different levels of intellectual abilities in different subjects. This can help generalize the findings of this study to a broader population. 2) This study only involved one control group and one experimental group. Therefore, further research can utilize more complex research designs, such as a larger control group, multiple experimental groups, or mixed research methods to strengthen the findings. 3) This study used AR technology in learning, but further research can compare the effectiveness of AR technology with other technologies such as virtual reality or game-based learning. 4) This study focused on a specific subject and topic. Further research can consider the use of AR technology in different subjects and topics to see how effective it is in various learning contexts. 5) Further research can consider other factors that may influence the effectiveness of AR technology in learning, such as student motivation and learning styles. This can help understand the factors that can enhance the effectiveness of AR technology in learning. These suggestions can help develop further research in exploring the potential of AR technology in enhancing students' learning outcomes.

CONCLUSION

This research demonstrates that the use of AR technology can enhance students' understanding and engagement in learning. These findings have important implications for improving the quality of education in schools and indicate the potential of using AR technology as an effective educational tool. The results of this study also highlight the importance of accommodating students with special needs in learning and showcase how technology can be a beneficial tool in achieving this goal. However, it is important to note that this research has limitations, including a small sample size and a limited research environment. Therefore, further research is needed to expand and confirm these findings.

Overall, the findings of this research indicate that the use of AR technology can provide benefits in learning and can be utilized as an effective educational tool in schools. The implications of these findings need to be considered when designing better and more inclusive learning programs in schools

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