Aspects Influencing Computer-technology Adoption in Secondary-school Physics Instruction in Jordan

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Abstract: This survey researched the aspects that inspire secondary-school physics teachers to utilize computer technology in instruction and learning in four areas of the Hashemite Kingdom of Jordan. To assess the research question, the survey used a quantitative review research strategy utilizing a survey questionnaire comprising of 25 Likert-type scale inquiries to determine physics teachers’ perspectives toward utilizing computer technology in physics lesson preparation and delivery techniques. In opposition to what might be anticipated, the results encountered several factors that were not indicators of statistical significance of physics teachers’ employment of computer technology in instructing physics: gender; academic degree; school location; normal class size; ways of acquiring technology skills, for example, self-taught and computer courses; instructional style; perceived barriers; and availability of technology resources. The findings verify the expectation that the lack of ICT tools in the Jordanian high-school physics curriculum has an impact on teachers’ job satisfaction, physics lesson preparation and delivery techniques and Tawjihi students’ individual learning styles. 

Keywords: ICT, ICT-driven classroom, Rogers’ diffusion of innovation theory.

Introduction

Recently, we presented a research in (Jordan J. Phys.) [1] that dealt with the factors motivating virtual lab simulations’ adoption in secondary-school physics instruction in Jordan. This is a complementary survey that is intended to discover and recommend practical solutions using Information and Communication Technology (ICT) to improve student learning and raise the Tawjihi students' scores in physics. Therefore, the survey is designed to investigate the aspects associated with computer-technology adoption in physics instruction to improve teachers’ job satisfaction that has a direct influence on their instructional performance and student success.

Fernandez (2017) has demonstrated that there is a relationship between students’ accomplishment on a standardized test and theoretical comprehension of thermal physics in the authentic inquiry-based instruction (AIBI) classroom. Conventional methodologies of teaching are insufficient, as they do little to expand students’ self-confidence and attention towards thermal physics. More accentuation ought to be set on inserting reliable and formative evaluation assignments throughout the educational plan instead of end-of-unit standardized tests [2]. Büyükdede and Tanel (2019) indicated that science, technology, engineering and mathematics (STEM) approach-based activities model utilized in work-energy problems brought about more prominent gains in
scholastic accomplishment contrasted with conventional teacher-centered instruction. The key explanation is that a student-centered instruction approach guides students to do research and inquiries and in particular, gives the chance to employ new learning through the plan of the item, hence making a sensation of imagination and contentment [3].

The survey aimed at investigating the usefulness of integrating computer technology into the Jordanian physics curriculum to motivate secondary-school physics teachers in Jordan to plan high-quality ICT-based lessons. Teachers utilizing computer technology successfully will definitely influence students by encouraging learning and increasing instructive expectations. Accordingly, teachers will feel increasingly contented with utilizing this innovation for lesson planning and preparation. Teachers who utilize traditional instruction techniques can be optimistically influenced and may integrate computer technology in their teaching approach. Teachers who recognize this innovation can utilize their experience to make lesson plans intuitively and integrate computer-technology usage in their conventional lesson demonstration. Students' awareness towards computer technology will also confidently influence them. Instruction will become student-centered and will expand student accomplishment. According to Gomes & Waits, Laughbaum (as cited in [4]) argued that utilizing appropriate educational technologies, for instance IT products and computers, as well as highly developed scientific calculators and a variety of instruction instruments, assisted in comprehending comprehensive learning and constructivist view-based learning to urge students into the subjects of lessons and improve their success levels.

Nguyen and John (2016) confirmed that Vietnamese teachers implementing constructivist and sociocultural-learning principles with ICT (CSI Model) efficiently improved their students’ physics optics content. ICT helped students internalize more knowledge through their visual modalities, for instance colors pictures, audios and videos, thus assisting learners to structure their own knowledge [5].

**Literature Review**

Conceptualized knowledge of technology, personal ownership of a technology device, collaboration, weekly hours spent on educational technologies and school support were investigated as independent variables. Utilizing computer technology in physics-lesson preparation and delivery in four areas of the Hashemite Kingdom of Jordan has been considered as the major dependent variable.

According to Trocaru (2016), teachers need to thoroughly consider the whole class throughout delivering new information by utilizing ICT. Those teachers must know that free bartering of thoughts between students could influence the didactic method. Frequently, students could not concentrate on the content in the lesson; however, they intercommunicate for their very own concerns, which might comprise issues such as learning difficulties, poorer than expected performance and lack of consideration from teachers. The concerns and inspiration of adolescents are continually changing, so the teacher must determine the amplified flexibility of the didactical techniques. The individual teacher’s teaching style turns out to be increasingly an important factor, which may expand the effectiveness of the instructional practice. The utilization of ICT, in the broad setting of the changed didactical methodology, steers to a desired expansion of student attention for the taught subject matter; namely, physics [6].

Chandrasekara (2019) indicated that there is a proportional relationship between job satisfaction and job performance, where higher level of job satisfaction leads to better job performance and *vice versa*. As teachers employ computer technology to improve their instructional performance, they are more presumably to be appreciated by students, parents and the principal and this will lead to increased student achievement [7].

According to Biju (2017), instructing physics at secondary-education level experiences the problem of verbal-expressions or unpremeditated experiments. In spite of the fact that inadequate endeavors have been made to incorporate apposite and applicable ICT tools in the current times of free and open-source programming, it will be astonishing if physics teachers and students can investigate the opportunities of incorporating Physics Education Technology (PhET) interactive simulations in their instruction and learning. Through constant preparation and experiencing, physics teachers
can boost the capability of ICT-driven classroom setting and steer students with advanced learning [8].

Zahrah Hussain, Pleasants and Horvitz (2017) indicated that ICT is utilized in several modes in the current classrooms, from online course-book modules to iPads. Isman, Yaratan and Caner (as cited in [9]) identified four various types of ICT tools: (1) traditional, incorporating writing slates, workbooks, whiteboards and drawing instruments; (2) contemporary, incorporating the web, calculators and camcorders; (3) PC, incorporating a variety of a computer program, computer hardware and scanners/copiers and (4) lab, incorporating Bunsen burners, gloves, goggles, pipettes and interface gadgets. Since students react optimistically to technology and are inspired by ICT tools, teachers must expose their students to activities to do exercises that include some variety of ICT tools. Students will improve their performance in school if provided with the opportunities and instruments they are most contented with (Atkinson, as cited in [9]).

Nguyen and Williams (2019) indicated that students using ICT to foster face-to-face presentations assisted in impressing their classmates and making learning gratifying. Although Vietnam's Ministry of Education and Training (MOET) educational reforms support the utilization of ICT to support teaching with a student-centered technique, a teacher-centered technique still regulates Vietnamese classrooms. The use of ICT enlightened by the Cognitive Strategy Instruction (CSI) model (see Figure 1) can improve the interactive learning environment, together with students' physics achievement and critical-thinking skills. The model may supply functional assistance for teachers who desire to incorporate ICT into their instruction practice [10].


According to Purba (as cited in [11]), smart phones are ideal ICT tools for learning in the physics lab due to the following major features: mobility and connectivity to the worldwide web as well as merged with sensors that any mobile phone has.

According to Arend, Weber and Sunnen (2018), video analysis techniques effectively helped teachers become reflective practitioners when compared to traditional forms of reflection. Video analysis simplified the complication of teacher-student communication throughout classroom activities [12].

Anderson and Wall (2016) emphasized that ICT-enhanced learning environment helped physics teachers interpret complex physics problems such as Newtonian physics. Through digital visualizations, students can understand kinematics using Kinect sensors that enable them to see themselves "embodying" displacement.
and velocity graphs. Thus, Kinect technology, resembling many game-based learning (GBL) practices, is highly appreciated as an instructional instrument in physics classrooms [13].

The theoretical framework of the survey is based on Rogers' diffusion of innovation (DOI) theory. According to [14], the Diffusion of Innovation (DOI) theory analyzes how and why choices to embrace a modern technology occur. Rogers (as cited in [14]) described diffusion as the procedure by which an advancement moves in the bounds of a social framework in a short time. While an advancement frequently alludes to physical bodies, it can as well incorporate thoughts, practices or practices that are new to the people in the bounds of a framework [14].

Rogers (as cited in [15]) indicated that there are four basic sections of diffusion of innovation: an innovation, communication channels, time and the social system. Rogers further demonstrated that the diffusion of innovation is influenced by five attributes: (1) relative advantage: how much innovation is observed as a way that is better than the thought it overrides; (2) compatibility: how much innovation is observed as being reliable with the current qualities, past experience and needs of likely adopters; (3) complexity: how much innovation is observed as hard to comprehend and utilize; (4) trialability: how much innovation might be tried out on a restricted premise; and (5) observability: how much the findings of innovation are noticeable to other people (Rogers, as cited in [15]).

Brekke and Hogstad (2010) indicated that teachers should meet their students' learning styles at the half way by implementing good computer-aided programs for this. Unsurprisingly, if the teacher is an ICT literate individual, this gives his or her students an immense improvement, since young students generally have good computer skills. By incorporating computer-based work into the physics classroom, the subject becomes "less boring", the students are more contented, expend more time studying and most significantly, achieve better academic performance. However, it must be emphasized that the use of computer tools should not replace conventional teaching methods [16].

Incidentally, the following research question was suggested:

Q: What are the varying aspects that encourage secondary-school physics teachers to improve their job satisfaction and physics-teaching methodology through employing ICT tools in public secondary-school classes in four areas of the Hashemite Kingdom of Jordan?

### Methodology

It is noticed that Tawjihi students' accomplishment in physics is moderately low contrasted with other science subjects; for example, chemistry, biology and geology. Practical investigations or virtual labs empower students to be involved trainees at the center of convergence of the learning technique, as opposed to being submissive trainees accepting all the knowledge from their instructors. Table 1 shows the mean achievement rates in science subjects from 2016-2019 for summer sessions in four areas in the Hashemite Kingdom of Jordan: Irbid (northern region), Al-Karak (southern region), Zarka (eastern region) and Amman (western region). Raw information was acquired from the "Tests and Examination Department" at the Ministry of Education and afterward was processed by utilizing the Statistical Package for Social Sciences (SPSS), Version 25.0.

<table>
<thead>
<tr>
<th>City</th>
<th>Mean Achievement Rate from 2016-2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biology</td>
</tr>
<tr>
<td>Al-Karak</td>
<td>58.98%</td>
</tr>
<tr>
<td>Amman</td>
<td>71.93%</td>
</tr>
<tr>
<td>Irbid</td>
<td>71.73%</td>
</tr>
<tr>
<td>Zarka</td>
<td>66.78%</td>
</tr>
</tbody>
</table>
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Respondents and Setting

The respondents in the current survey were 120 (60 male and 60 female) high-school physics teachers within the age range of 20-60. The respondents work at public high schools in the four cities in the Hashemite Kingdom of Jordan: Irbid (northern region), Al-Karak (southern region), Zarka (eastern region) and Amman (western region).

Instrumentation

The tool used in this survey was a Physics Teachers' Survey (PTS) questionnaire comprising 25 Likert-type scale inquiries to evaluate physics teachers' viewpoints toward utilizing computer technology in physics teaching.

Data Collection

Data collection of the survey contained a quantitative technique that utilized a questionnaire survey instrument. The questionnaires were circulated in person and electronically utilizing Google Forms through the Jordan Physics Teachers Forum so as to reach as many physics teachers as possible in order to fill out the questionnaires. The gathered data was inserted into a Microsoft Excel spreadsheet and then exported to the Statistical Package of Social Sciences (SPSS), Version 25.0 for multiple-regression analysis.

Results

Table 2 presents information on the teachers’ gender and age group.

Table 3 illustrates the highest completed academic degree and high-school physics instruction experience.

Table 4 illustrates the school characteristics that were collected in the survey. School characteristics included Internet access availability and places in addition to classroom-computer availability.
TABLE 4. School features.

<table>
<thead>
<tr>
<th>School Characteristics</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability and Places</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes: Home</td>
<td>54</td>
<td>45.0</td>
</tr>
<tr>
<td>Yes: School</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Yes: Both</td>
<td>61</td>
<td>50.8</td>
</tr>
<tr>
<td>I do not use it</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100.0</td>
</tr>
<tr>
<td>Classroom-Computer Availability</td>
<td>Laptop</td>
<td>1</td>
</tr>
<tr>
<td>Availability</td>
<td>No</td>
<td>119</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 5 illustrates the results of multiple regression described based on the unstandardized regression coefficient B, standardized regression coefficient $\beta$, 95% confidence interval and statistical significance.

TABLE 5. Outline of the model parameters.

<table>
<thead>
<tr>
<th>Model Parameters</th>
<th>Predictor Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta ($\beta$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics teachers' qualities</td>
<td>(Constant)</td>
<td>3.837</td>
<td>1.329</td>
<td>2.887</td>
<td>0.005</td>
<td>1.205</td>
</tr>
<tr>
<td></td>
<td>Knowledge of technology</td>
<td>-0.060</td>
<td>0.128</td>
<td>-0.044</td>
<td>-0.470</td>
<td>0.639</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2.127</td>
<td>0.917</td>
<td>0.219</td>
<td>2.320</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Personal ownership of a technology device</td>
<td>0.343</td>
<td>0.195</td>
<td>0.173</td>
<td>1.756</td>
<td>0.082</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>2.127</td>
<td>0.917</td>
<td>0.219</td>
<td>2.320</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Time spent on educational technologies outside classroom</td>
<td>2.127</td>
<td>0.917</td>
<td>0.219</td>
<td>2.320</td>
<td>0.022</td>
</tr>
<tr>
<td>Leadership practices</td>
<td>(Constant)</td>
<td>2.000</td>
<td>1.207</td>
<td>1.656</td>
<td>0.100</td>
<td>-0.392</td>
</tr>
<tr>
<td></td>
<td>School support</td>
<td>0.750</td>
<td>0.127</td>
<td>0.518</td>
<td>5.901</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Discussion

After processing the data gathered from the (PTS) by utilizing the Statistical Package for Social Science (SPSS), Version 25.0, the following socio-demographic profile (Tables 2 & 3) of physics teachers was made. The sample consisted of 60 female teachers (50%) and 60 male teachers (50%) as well. Age group was the second socio-demographic, with the uppermost consideration of teachers lying in the 31–40 (43.3%) year range.

Most of the teachers were classified into young adults. Potential justifications comprise lowering the optional retirement age of public-school teachers from 60 years to 55, high teacher turnover rates and teachers moving into administrative roles and responsibilities. A bachelor's degree was the dominant academic degree attained by 89 physics teachers in this sample (74.2%). Just one teacher informed an attained doctorate. The Jordanian Ministry of Education demands teachers to have a bachelor's degree in physics to teach in secondary schools.
This qualification condition could justify the great number of teachers with a bachelor’s degree in the sample. High-school physics instruction experience ranged from 3 to more than 20 years, with the greater part of physics teachers having tutored 3–10 years (37.5%). The 3–20 year category denoted 75.8% of the sample. Physics teachers who taught 15–20 years could have relocate to administrative positions and so, they could be more likely to stay away from responding to a random survey. Having teachers with 3–10 years in the classroom can make the teaching setting more beneficial, as these teachers are assumed to be better equipped to administer classroom matters; for example, discipline and lesson preparation and delivery techniques.

The school characteristics (Table 4) included Internet access availability and places and classroom-computer availability in addition. Internet access in schools was rated poorly (2.5%) and only one classroom had a computer (0.8%). Once more, low Internet access and providing classrooms with a computer may have to do with the Jordanian Ministry of Education budget available especially to support computer technology in schools. If schools are short of computer resources, utilizing computer technology for lesson preparation and delivery techniques as well as adapting with students’ individual learning styles become extremely problematic, if not unachievable.

Table 5 shows that the 95% confidence intervals for all the five predictor variables did not comprise zero and consequently, in 95% of the chosen sample, the interval estimate involved the true population parameter. This indicates that the five predictors can precisely predict prospective use of computer technology in teaching physics. Multiple regression analysis gave rise to a better statistical model. Three of these variables, knowledge of technology, personal ownership of a technology device and collaboration, served as controlled variables. Concentrating on the association between each predictor variable and the use of computer technology in teaching physics; personal ownership of a technology device and collaboration significantly predicted using computer technology in teaching physics. Though, knowledge of technology slightly predicted using computer technology in teaching physics. School support significantly predicted using computer technology in teaching physics while weekly hours spent on educational technologies moderately predicted using computer technology in teaching physics.

Raising one unit in each one of the five predictor variables produced a percentage variation in the use of computer technology in teaching physics by the following: school support (β = 0.518), personal ownership of a technology device (β = 0.219), collaboration (β = 0.173), weekly hours spent on educational technologies (β = 0.116) and knowledge of technology (β = -0.044). The overall regression model explained 31.7% (which is of a significant effect as indicated by Cohen’s conventions) of the predicted variation in the use of computer technology in teaching physics. The estimated coefficient of determination ($R^2$) was 28.7%. Obviously, both values were not significantly different, which implied that using computer technology in teaching physics was entirely explained by the predictor variables in the multiple-regression model. These results imply that school support and personal ownership of a technology device have to be borne in mind as main concerns throughout the integration of educational technology in schools. Pre-service teacher training programs should incorporate technology training to make sure that younger physics teachers graduating from college are provided with sufficient technology skills for teaching physics.

The survey showed that personal ownership of a technology device, collaboration and weekly hours spent on educational technologies may bring about advanced teacher usage of computer technology; they may influence students optimistically and inspire teachers to incorporate computer technology in their instruction approach. School support was the strongest predictor of the use of computer technology in teaching physics in classroom teaching and learning in the four areas of the Hashemite Kingdom of Jordan: Irbid, Al-Karak, Zarka and Amman. In other words, school leadership encourages physics teachers to be greatly convinced with the computer technology accessible in their classrooms to get them stay in the profession with greater job satisfaction, to achieve an effective classroom management and adapt their instruction strategies to student needs. Leaders have an effect when encouraging teachers to use computer technology. Since
computer technology is a current innovation, it has to be approved by the school leadership so that teachers get inspired to utilize it for lesson planning and preparation. When teachers are appreciated by their principals due to their effective use of ICT tools in physics classes, their job satisfaction will increase and directly influence their instructional performance and students’ achievement.

Using computer technology is not intuitional. It needs constructive perceptions, knowledge and devotion to co-workers. These characteristics would only be improved by a principal who has faith in his or her teachers and endorses their attempts in employing computer technology for lesson planning and student motivation. Nevertheless, there are other means by which teachers can acquire technology. For instance, computer courses and being self-taught were not predictors of statistical significance for computer-technology adoption and thus, they were not included in the regression-analysis model. It should be pointed out that instructional style variable was not a predictor of statistical significance for utilizing computer technology in teaching physics due to its very low beta (β = 0.001). Therefore, this variable was eliminated from the regression-analysis model. Moreover, perceived barriers and availability of technology resources were also eliminated from the regression-analysis model.

Conclusion

This study supplied information about what contributed to successful adoption of computer technology, specifically for the enhancement of teachers’ job satisfaction and physics teaching in public secondary-school classes in Jordan. Implications for policy and practice handle two major issues:

1. Improving Classroom Usage of Computer Technology

Teachers in the survey showed deficient abilities to utilize technology for physics instruction, implying teachers’ lacked knowledge about how to employ technology in physics instruction. There is no argument that training Jordanian teachers can change the way they consider technology and the way they utilize it in their classrooms. As a result, physics teachers will make beneficial usage of computer technology so that their students may change the way they think about physics, since technology can help them think critically, explore situations, make generalizations and perceive patterns. Still, stakeholders have various roles to play in supplying ICT infrastructure and training for secondary-school teachers: banks should contribute and install ICT facilities in schools and local governments should supply Internet connectivity to schools.

2. Revising the School Curriculum and Supplying Planning Time

The existing education in Jordan lacks digitized school curriculum and does not reveal the way technology can be employed to demonstrate physics. For that reason, ICT must be incorporated into school curriculum and a class period must be extended from 45 minutes to a 55-minute period for successful adoption of technology in physics instruction. The existing Jordanian school curriculum keeps teachers busy and makes them feel overloaded due to their everyday instruction duties and the extra responsibilities they have outside the classroom. Accordingly, the Ministry of Education must commit itself to hiring more teachers in order that physics teachers have less roles to play outside the classroom. Yet, stakeholders such as teacher education institutions should develop ICT software in different science subjects for use in secondary schools.

The results of the survey may be beneficial to the educational community:

(1) Physics teachers who do not incorporate ICT tools in their teaching may improve their students’ critical thinking, theoretical comprehension of high-school physics and lab experience by bringing about an interactive classroom setting through using smart phones, apps, virtual reality and visualisation tools;

(2) Queen Rania Teacher Academy (QRTA), as a teacher training institution, might be authorized to make an educational decision to modify their training methodologies and lay emphasis on ICT-based instructional technologies.

(3) Curriculum developers in the Jordanian Ministry of Education (MOE) may make use of the results of this survey to change their methodology in designing the physics curriculum by incorporating more ICT-based practical labs into it.
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References


