M-learning: Effectiveness, Unknowns and Opportunities

Dr. Jeff M. Shannon Ed.D

IT Instructor - Continuing Education Coordinator, KY Tech, Louisa, United States

Abstract—The portability of m-learning presents innovative opportunities for educators and the learners they serve. However, how prepared are our students to incorporate this option into their current academic routines? This study focused on the current state of m-learning as it applies to high school juniors and seniors. Learners participating in technology related courses were targeted. It was decided that these learners would be more likely to have experience and valuable feedback in the area of mobile devices being used for learning. The results from this study came from data compiled on 130 high school juniors and seniors in technology related courses. A total of 8 high schools were studied. Kentucky provided data from 6 high schools, 2 high schools in Ohio participated, and 1 high school in Virginia. Prior to the study it was predicted that motivation would be high for the use of mobile devices for learning. In addition, learners were assumed to be already using their mobile devices to obtain information beyond mere social activities. As growth in this area continues, it was determined that the safety factor should also be examined. The results are consistent with these forecasts.

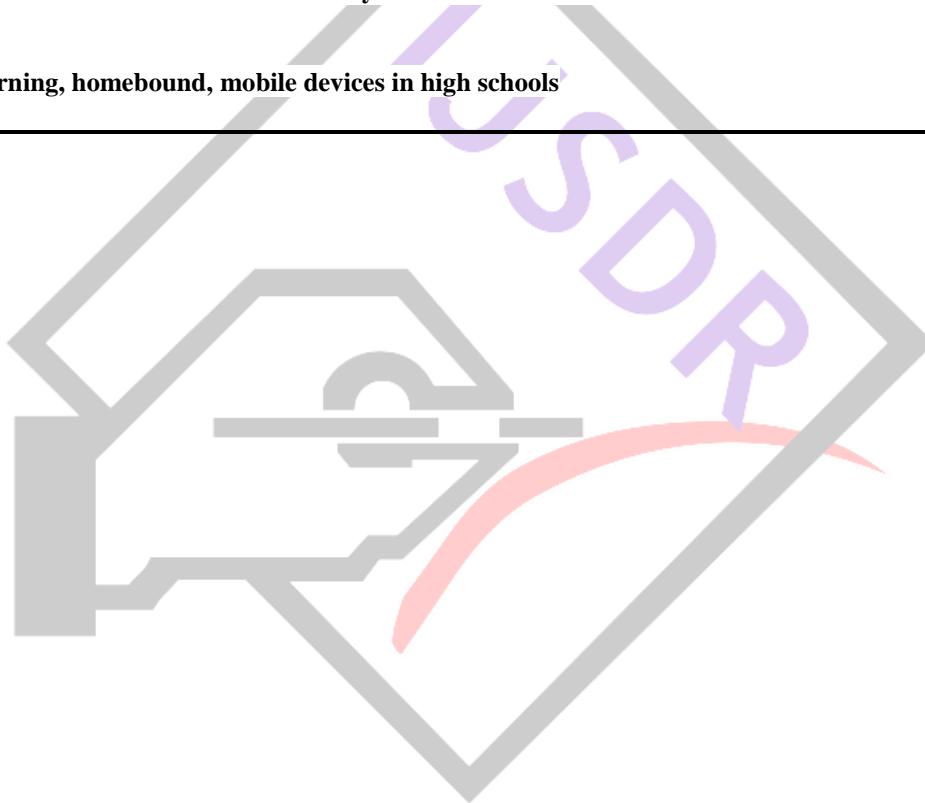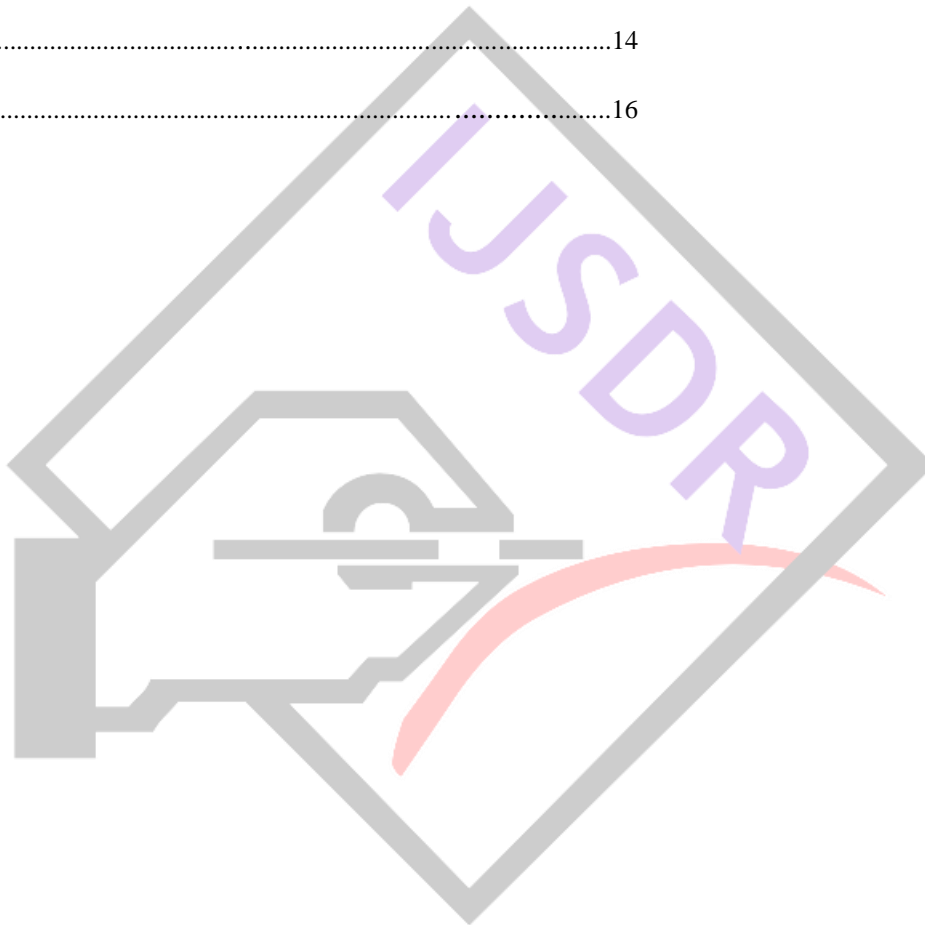*Index terms*—**m-learning, homebound, mobile devices in high schools**

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I. INTRODUCTION

What if there was an option to remove the physical boundaries from learning? A means to keep learners engaged, regardless of environment and conditions. The field of education would benefit from a method that can tie classroom activities to everyday challenges. This alternative may actually be less futuristic than one might imagine. Such a mode of content delivery has been on the horizon for some time now. It is referred to as m-learning. As stated by Mcconatha, Paul & Lynch (2007), "M-Learning is learning accomplished with the use of small, portable computing devices. These computing devices may include: smartphones, personal digital assistants (PDAs) and similar handheld devices" (p. 1). The use of this innovative option is currently limited in comparison to other methods of delivery in distance education. However, it is rapidly evolving and showing promise in multiple educational venues. As with any unconventional opportunity, obstacles and possibilities must be researched to determine how to best apply this multimedia bridge.

The portability of m-learning allows it to provide effective solutions to lingering problems in education. Keeping learners engaged while on homebound qualifies as one of these difficult areas. According to Connections Learning (2011), "Educating middle and high school students is particularly challenging in traditional hospital and homebound programs as these students need their lessons delivered by subject-matter experts; it is rare to find a homebound instructor who is certified across multiple subjects." This brings us to the heart of just one of the problems that may be remedied with m-learning. It is an importunate imbalance in the system that can be alleviated with the advent of recent advancements in m-learning.

The focus of this works sets out to answer a specific question about this multimedia option. Can m-learning fill the gaps of engagement between instructors and learners beyond the walls of the classroom? According to Corbell & Veldez-Corbell (2007), "Mobility allows teaching and learning to extend beyond the traditional classroom; in the case of distance learning, users of portable devices can break the tether of the home computer" (p. 54). If one examines the concept of mobility, the possibilities of m-learning begin to emerge. Imagine the increased opportunities that coincide with having more freedom in ones education. For example, a high school biology lab could become virtually extended to reach a stream at a student's home. Courses would also be strengthened by having an additional opportunity for students go out and apply information they have just acquired. The capabilities of m-learning would finally provide educators with a way to systematically observe and assess these endeavors beyond the classroom walls.

So why is this research so important at this stage of the game? The evidence presented thus far sets the stage for such a valid question. To put it boldly, m-learning brings us one step closer to truly evaluating knowledge transfer. Now we arrive at the root of a major issue in education. It is reasonable to consider, as a collective body, students do not seem to be taking the information that is being provided to them and applying it in their daily lives. The instructor may use multimedia such as a projector or a whiteboard to introduce a topic, complete reinforcement exercises and even have students participate in a predetermined lab activity. On the surface, instruction and application may appear as the solution to transfer. Looking through a more focused lens, at what point did any student personally view the information being provided graphically and audibly as something they can use? Even when learners physically apply the new material in a lab, associations beyond the school walls is not a guarantee. It is logical to consider that a few students make this leap, but it is most likely a result of high prior knowledge. This prior knowledge is a major asset to m-learning and will be addressed in later sections of this work.

A few out of thirty is a marginal failure at best. This is where the problem persists exponentially. Are you ready? It is when we arrive full circle, back to one of our focus areas, deeper problems emerge. The homebound student was not even physically present to view and interact with the proceedings. Proceedings that have proven time and again to be limiting in regards to long-term transfer with the students that are present. If only a few students are prepared to be adaptive with the new information, industry is going to continue to suffer when trying to get new employees to reach high levels of productivity. Furthermore, retooling is a daunting task in any industry. If new hires become more accustomed to viewing information supplied by multimedia through this adaptive lens, a company will be able to upgrade and meet consumer demands more seamlessly.

II. REVIEW OF LITERATURE

The literature on m-learning is plentiful. Information on homebound is often limited to specialized focus areas at best. Documentation on the two crossing paths is scarce. This speaks volumes about a group that has been provided little voice. The South Carolina Department of Education (2003) stated:

> If a student becomes medically unable to attend school while taking classes that require a lab and/or the use of school equipment, the classroom segment of the instruction could possibly be done at home, while the student would have to make up the lab portion of the class after he or she returns to school. (p. 9)

This is a commonly accepted practice in school districts. While access to personal subject-matter experts and major equipment is not a feasible option, interaction is. M-learning provides this needed interface that is both practical and effective. These innovations allow a student to remain included and more on track while on extended leaves of absence.

The Virginia Department of Education (2012), ranks research in these distance options a priority and cite it as a possible future procedure. Such proposed investments highlight the need for school districts to bridge the gap beyond the classroom walls. This call for technology is echoed in the majority of the documentation provided online in regards to homebound programs.

The focus of the research examined is primarily pointed in the direction of integration, learning environments and the lack of tangible data from institutions. We now find ourselves at somewhat of a crossroads. As the sage on the stage begins to take shape as monolithic, school districts and universities are turning to technology for assistance. Kristen Peters (2007) articulates it best by stating:

> The research found that mobile technologies were in common use in some commercial sectors, but their use purely for learning was rare. M-learning lends itself to new methods of delivery, however, that are highly suited to the 'just enough, just in time, and just for me' demands of 21st Century learners. (p. 1)

Common perspectives seem to exist on a felt need and an acceptance of m-learning's potential. However, it begins to get murky in terms of specific courses of action. Businesses, secondary and especially post-secondary are, for the most part, expressing an interest in m-learning. There is a shared view, though not unanimous, that it can extend instruction in both depth and in the geographical sense.

Park (2011) points out, "In many empirical research studies and pilot tests, participants owned the handheld devices (even though it was temporary), and such ownership involved them more in the learning process" (p. 82). Ownership of the learning device could have an impact on motivation. Our society is continuously looking for reasons to use their smartphone or other mobile device. Perhaps learning could be one of these reasons.

Education takes on many faces. The military has been examining m-learning for a while now. Olsen, Godcharles & Meloy (2012) stated, "With improved software and hardware in the future, mobile learning could facilitate intelligence sharing between soldiers in the field and revolutionize military tactics in the battlefield" (p. 4). Again, we see evidence of officials recognizing the vast potential through portability. The rapid evolution of the technology is causing even the largest organizations to reassess uses and limitations. Laborda, Magal-Royo & López (2011) provide incite into the use of m-learning for foreign language purposes. The results provided seem to highlight the positives in terms of listening and speaking tests, flexibility and general training. However, they do discuss the limitations associated with keyboard capabilities and assignments that require long text responses (p. 96). This can be overcome with design and discovering an effective purpose for the technology. The main goal of m-learning is not to completely replace other devices. It is to be able to connect during learning conditions that were previously out of reach.

According to Keskin & Metcalf (2011), the m-learning field will become more understandable for new researchers when it is aligned with the theories, approaches and definitions that currently exist in education (p. 207). This feat hinges on some important factors. These factors include time, interest, development and acceptance to name a few. The overwhelming motivation and perceived need for m-learning can overcome many of these areas. However, acceptance of the multimedia as an equal may continue to prove difficult due to varying perspectives on the DOK that can be reached by such means.

Another field that is heavily researching the opportunities of m-learning is nursing. As stated by Kenny, Kenny, Park, Burton & Myers (2009), "While these main aspects are clearly important, we believe that it is the interactions between them that are most likely to determine the effectiveness of m-learning" (p. 77). M-learning offers an enticing means of interaction on projects. When designers intertwine the technology with discovery it results in a multitude of benefits. For example, it can be difficult at times to produce lengthy, or probing, interaction through discussion boards. M-learning, likely as a result of the high motivation for the technology, naturally combats this problem. Learners perceive the task in a more positive light. This fascination with mobile devices appears to drive individuals to seek a purpose to use them. If this trend continues, education will be presented with great opportunities for interaction.

Yashun & Mills (2007) argues, "Mobile technologies have sparked the need for the strategies, applications, and resources necessary to support anywhere-anytime connections to formal and situational learning, as well as personal interest explorations" (as cited in Wagner, 2005). This helps to bolster a need for additional research. M-learning extends the reach of the instructor. The multimedia can be used in new ways to link course material to personal interests of the learner outside of the school walls. For example, a student may have a passion for billiards. They may also be struggling in geometry. Who could argue with the possibilities here? M-learning becomes a bridge between the passion and the educational challenge. This also remedies the learner's outlook on the material actually having purpose beyond the classroom.

According to Cochrane (2010), cognitive load can be minimized with the use of the m-learning approach. Per the examination of five case studies on m-learning the conclusion of the lengthy research states, "The m-learning projects have also provided proof-of-concept that the pedagogical integration of WMDs into course curricula can provide a catalyst for pedagogical change towards a social constructivist pedagogy facilitating student-generated content and student-generated learning contexts beyond the classroom" (p. 66). From the research available on the subject, it generally appears that students benefit greatly from learning in environments that are more stimulating to them. It is as though their working memory becomes unchained. It appears to occur through a combination of intense focus through motivation and increased opportunities to incorporate prior knowledge through portability.

However, Abik & Ajhoun (2012) argued that effectiveness based on the technology alone did not provide remarkable results in the projects associated with their research. They assert that it is adequate pedagogy that assures quality of learning with this type of integration (p. 230). Once again, it is evident that the multimedia alone will show no significant difference. Incorporating mobile devices into special projects or homebound programs alone is not enough. The technology must align and assist with the problem being addressed. Getting back to our original question, it must fill a gap between instruction and practice. From the research available, it appears that delivering instruction on mobile devices will not automatically increase transfer. The benefits are in the increased opportunities to tie the instruction to practice. Then the odds are more favorable for additions to long-term memory.

The advantages are reiterated by many. According to Rummler, Selpold, Lübcke, Pachler & Atwell (2011), "Learners do media based research and document their learning in environments (e.g. nature, libraries, museums) not traditionally associated with technology enhanced learning. Thus teaching gets more connected with reality" (p. 83). There appears to be a widespread calling from educators for a means to easily connect content to its use in the world. This is a major factor that is driving research in this area on the institutional side. If an institution can make the claim that their programs will help a student more in life than a competitor, reactions to such claims can prove lucrative.

Many of the unknowns surrounding m-learning relate to its overall effectiveness. Yang (2012), argues in favor of m-learning as he states, students express their continual use of mobile devices to learn the material (p. 148). If further research can prove that learners are more likely to continue to apply the new material after instruction has moved on, m-learning may finally receive the accolades it deserves.

Rapetti, Picco & Vannini (2011) stated that research shows this transfer is not happening naturally. However, they do add that this data is pulled from a study of mobile users for the informal use of mobile devices. Also, the work points out researchers would need more access to institutions actually using m-learning as a teaching tool (p. 56). For our research, such a claim is profound for a different reason. It highlights the point that society may be categorizing these devices and their use. This has implications in both directions. Learners may be motivated by an association with the social and entertainment features of the device, as opposed to its opportunities for learning through portability. Furthermore, school districts and institutions may be viewing technology, such as handhelds, through this lens. Data may be limited due to acceptance rates in certain environments and a fear of safety and liability. While these views are with merit, under some conditions, it does appear to be an obstacle to data collection in these environments.

Again, it is important to address the negatives and unknowns of m-learning in order improve the odds of continued growth. Suki & Suki (2011) performed a small study of twenty students to better determine student's acceptance of mobile devices as a learning tool. An area that seemed to draw strong responses was those related to mobile devices being compared to and replacing current devices (p. 51). The question being asked and the responses provide areas for further thought. There seems to be a feeling that exists in some, in regards to technology, that newer and smaller must completely replace older and larger. This is the same as proclaiming the sledgehammer must cease to exist in order to make way for the pneumatic air nailer. The two technologies have more than one function. They also lend themselves better to certain applications. The view of one should not be tainted by a forecasted eradication of the other. This is especially true when the objectives for the two greatly differ.

These differences in computer and mobile applications have an impact on perception and research. These technologies both have their limitations. Rekkedal & Dye (2007) stated, "More than half of the students in the trial course were uncertain – or disagreed – with the statement that graphics and illustrations are necessary for m-learning to be effective" (p. 14). This is a productive view of m-learning and its capabilities. The functionality of a device or application can compensate for limitations such as size and graphics. Caudill (2007) states, "One environment may utilize m-Learning as a single component of a single topic, while another environment may be dedicated to using m-Learning as the only means for learning" (p. 3). A healthy view of m-learning consists of seeing it as an extension of the educator's reach as opposed to a halt to productive practices already in place.

So does the literature support question at hand? Can m-learning fill the gaps of engagement between instructors and learners beyond the walls of the classroom? If motivation is factored in as an indicator the argument strengthens. Corbell & Valdez-Corbell (2007) provide the results from a lengthy study on m-learning. According to the results, 94% of learners are ready to make the switch to m-learning. Faculty motivation was sizably lower with 60% eager to make the move (p. 57). Further research is definitely needed in this area to determine whether motivation is high due to a genuine desire to learn under these conditions. It is logical to consider that the results on the learner side are so high due to a presumption that coursework will be easier.

This does increase opportunities to a degree, but as stated earlier, there needs to be a way of connecting the new information with the application of it. M-learning provides a bridge between the two.

III. CONCEPTUAL FRAMEWORK

Young learners, for the most part, are accepting of new technologies and the addition of them into the classroom. There are opportunities at the doorstep. The increased levels of motivation can be used to the instructor's advantage. The problem lies in mindset of the student as they enter the door. It is important to point out that young learners are more accustomed to viewing multimedia technology than using it to solve daily problems. School districts are also trying to shift the focus to using technology for applicable reasons. M-learning takes this goal to new level. The opportunities created by the increased mobility allow a learner to view the content, device and activity as a means of solving a tangible problem that exists in their own world. Instruction begins to take on a new face. The focus shifts away from rote memorization and the steps involved in learning an application through trivial activities. Student perspectives during the instructional process become aligned with personal goals. On the surface, such a distinction may seem small in nature. In reality, nothing could be further from the truth.

It is fascinating how quickly young learners begin to assess their educational environment. During this phase there are several items that the learner is trying to discover. The more common examples of this initial assessment would include strictness on behavior and course difficulty. There is another major area that seems to get overlooked more often in comparison to the previous two examples. To add to the severity, it may be the one linked closest to instruction. Learners will immediately ask a valid question when presented with information by means of multimedia. What am I going to use this for? The answer to this initial question will continue to try to cement itself in the learner with the delivery of each additional section of content. As with the addition of any new technology, the mere presence of it in the classroom solves nothing. Announcing that m-learning will now be included in regular activities will not alter initial perception on technology. It will not make learners view the coming information, delivered by multimedia, as a valuable resource they can adapt with later. In regards to technology integration, to arrive at anything substantial there must be a concerted effort to balance technical rigor with personal relevancy. It is not a major leap to consider that continuing to overlook this important aspect is the same as not setting knowledge transfer as an overall goal.

IV. METHODOLOGY

Design

In order to gain a better understanding of the current state of m-learning, it was logical to focus attention on the design of the instruments to be used for data collection. Due to the unique nature of this research and the implications for homebound instruction, surveys were developed and administered. A mixed-methods approach was taken in order to more efficiently pull data on the quantitative side, while still gathering insight by way of open response for qualitative purposes. Participants were

chosen specifically from technology courses in order to in order to have a healthy sample of learners with access and experience with mobile device technology on a daily basis.

Participants

Data was collected from 130 junior and senior high schools students. Kentucky provided data from 6 high schools, 2 high schools in Ohio participated, and 1 high school in Virginia. These students were all enrolled in technology courses at the time of data collection. Participation in the study occurred on a purely voluntary basis. All responses remained anonymous throughout the research.

**Connecting Design with Applicability**

The availability, portability, and motivation towards m-learning makes it a rich area for future research. Having more concrete evidence on high school student's usage of mobile devices furthers research in patterns that can be analyzed and applied to new instructional models.
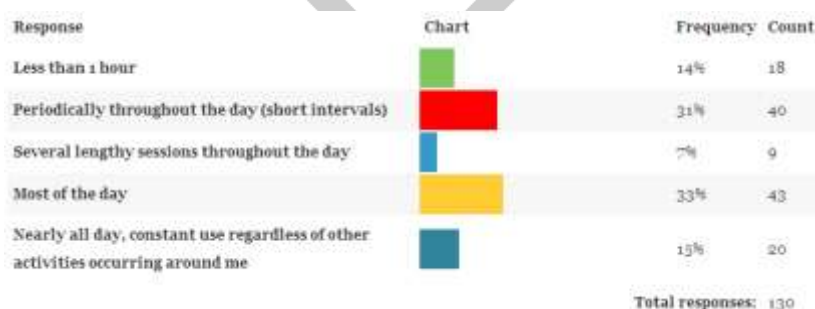
V. RESEARCH LIMITATIONS

This research was limited to learners enrolled in grades nine through twelve. In addition, the participants were enrolled in technology-based courses. It is worthy of note, this presents a threat to validity in the sense that the data may not be generalizable to older adults, or even learners who may not favor technology to such a high degree as to enroll in a technology program. The selection process of participants from technology courses has the potential to cause a regression towards the mean in terms of motivation towards mobile device usage. However, it was determined acceptable for this early research, as it still reveals patterns mobile device use at this age range.

VI. FINDINGS

Out of the 130 students who participated, 91% reported being an active owner and user of a personal mobile device. This illustrates that the majority of the subjects being studied have possess a background in the area they are being questioned. It is also probable that at least a portion of the remaining 9% has some experience with mobile devices through school or acquaintances but do not actually own a device themselves. One area that can be agreed upon is the strong desire for these devices among this age range.
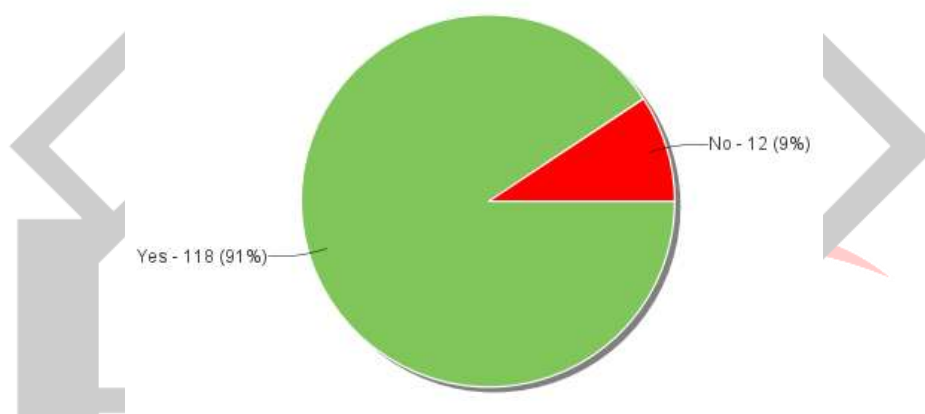
Another area that needed to be addressed related to the amount of time these students typically spend using these devices. The results below help to shed light in this area.

Response	Chart	Frequency	Count
Less than 1 hour		14%	18
Periodically throughout the day (short intervals)		31%	40
Several lengthy sessions throughout the day		7%	9
Most of the day		33%	43
Nearly all day, constant use regardless of other activities occurring around me		15%	20
		Total responses:	130

The majority of participants evaluated their mobile device use as either in *short intervals* or *most of the day*. Even though *most of the day* was a top choice, this would not necessarily mean that lengthy assignments would be the favorable design choice for assignments. With a variety of applications and contacts available, it is unlikely that students are spending most of the day searching for interrelated technical information or even on the same task for this duration. It is also important to note that the choice related to *several lengthy sessions* received the lowest percentage to describe student patterns of usage. However, this by no means eliminates m-learning as a viable opportunity for learning.

According to the results of this study, 76% of students feel that they are better than average when it comes to locating information with a mobile device. This is amplified by the additional 72% of participants who preferred the idea of using mobile devices for assignments. Up to this point, results have presented some argument in favor of motivation and preference for

instructional design. A major question that remains relates to the perceived effectiveness of m-learning once it is applied outside of the building.

A total of 76 students were recorded as having previous experience with homebound. Of these students, 87% stated that the portability of mobile devices would have kept them from falling behind while receiving homebound services. This may present an area for additional research for local school districts. It may even help to offset some of the impact of home-schooling that is currently being experienced in our high schools.

Would you try harder to complete an assignment, outside of school, if a mobile device were used as the means of gathering and submitting information?

Response	Chart	Frequency	Count
Yes		75%	98
No		25%	32
		Total responses:	130

The most promising data in favor of m-learning was found in the area of perseverance. The results show that 75% of participants state that they would try harder on an assignment if they could use mobile devices as a means of gathering and submitting information. If three quarters of students were to put forth a greater effort and have the added opportunity of applying new information in the real world it would be a win-win for students and our future workforce.

It is often assumed that our young people are simply using these devices for social purposes. During this study, it was interesting to find that 92% of these juniors and seniors are using their mobile devices to locate either academic or technical information. In addition, 8% stated that it has become their primary means of finding information. This is particularly fascinating when one considers that the majority of their assignments are presented on and designed for standard workstations. Even under these current conditions, students are already choosing to perform the research on their mobile device.

Towards the end of data collection phase, students were presented with a scenario. This activity related to the effectiveness of mobile devices when learning a completely new topic. Students were presented with the options of using mobile devices to discover patterns of moss growth, geometric shapes in architecture and activities in sociology. Under these conditions, 85% of participants stated that and option to record and communicate findings with a mobile device would increase the depth in which they learn. In addition, 75% of students felt that m-learning would have the power to make their peers try harder in school. This perspective may prove valuable in future research with the opportunities already in place to rate the performance of mobile activities in real time. However, it is important to not draw conclusions from anonymous data alone.

The opportunity to personally interview 15 of these students later presented itself. During this interview students were presented with the total results and were asked to comment on the findings. In hopes of obtaining more specific feedback on limitations of the study, they were then asked if there were any important areas missing that should be addressed.

In the general area of incorporating mobile devices into their regular activities, students felt that academic honesty may be an issue. Many of these students believed that their ability to communicate in this way is so effective it would make it difficult for the teacher when trying to get original and authentic responses. However, this could be viewed as a major positive when viewing it through the lens of trying to increase communication as a whole. The option could, in theory, provide a voice to some students that would normally take a more passive role in group assignments. In any event, students do appear to recognize the power and effectiveness of this medium. The students stated collectively that harnessing this power of communication would eliminate the problem. Their preferred method of accomplishing this was to seek out new opportunities for teamwork on project oriented assignments as opposed to quizzes and related tasks. They were later asked if there were any additional areas in the homebound aspect of the study that needed to be addressed further. An interesting point raised during this portion of the interview involved the possibility of students wanting to get on homebound or extend homebound services when it is not completely necessary. To some extent, these comments demonstrate the motivational power of m-learning.

VI. REFLECTIONS

Upon consideration of the data and the resources reviewed during this research, m-learning and its present state has come more into focus. There are challenges on many levels for this multimedia option to be considered mainstream. There needs to be more research focused on the addition of the technology, as opposed to it replacing other forms of technology that often serves a differing purpose. School districts need to consider procuring funds to provide handhelds to homebound and special projects, then, follow-up and compile data on its effectiveness. These devices should be accompanied by specialized applications, parent consent, restrictive software and configurations. M-learning and its associated applications needs to be focused on solving specific challenges to, and limitations of, instruction. It is understandable that additional safety measures may need to be addressed when implementing new methods of instruction. On a related note, 63% of students stated that they send and receive text messages while driving. As our society moves more and more towards these devices, a new commitment to safety must emerge.

Institutions of higher learning need to make an effort to compile data on students that are using specific mobile applications for learning purposes. It may seem obvious, although the literature paints a different picture; feedback from these students will provide the data needed for the growth of m-learning. Students who merely own a handheld device should not be the primary

focus for data collection under these conditions. It should be the patterns of use and the depth of learning as a result of instruction being extended through added portability.

Instructional design must be tailored to meet the capabilities of mobile device displays. There must be an understanding on the part of the educator that m-learning is compact. From this research it is concluded that the ultimate test to m-learn or not to m-learn comes down to a fundamental realization. This compaction of content should in no way be viewed as a limitation. It should be seen as an opportunity to provide just-in-time information to motivated users. It should be envisioned as an effective bridge to maneuver over gaps between the classroom and application in the learner's own world. A lesser view should signal a red flag to an instructor at that specific point in time.

Further research is needed to determine whether or not we are truly ready to switch to m-learning entirely. In other words, the act of replacing blocks of courses with this portable approach. This must consist of informing learners of the design of such a system prior to surveying them. To do so effectively, in basic terms, may require them having something to look at. Participants would make a more informed decision if they could see an example of the multimedia in action. This allows researchers to ask additional, perhaps more important, questions related to long-term memory. Faculty would also benefit from the additional exhibit. It could remove some of the anxiousness associated with change. This process could allow more people to make an informed decision on whether or not m-learning can fill the gaps in their own lives.

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